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Command Policy

THE QUALITY APPROACH

DEPARTMENT OF THE AIR FORCE

The Quality Approach

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Air Force Quality Institute

Forward...

Over 1,000,000 copies of the previous editions *of The Quality Approach* and *Process Improvement Guide* are in print. With that many books in print, why are we publishing a third edition? Simply put, in a dynamic world it's not enough to merely keep pace with our adversaries, we must constantly seek better ways of accomplishing our mission. To be effective, we have to be out front, seeking a better, faster and cheaper way of doing business. The third edition of this book is designed to help you find better ways to accomplish your mission.

The biggest change you'll notice in the two books is that they are now one book. That's right, based on input from numerous customers, we've combined AFH 90-502, *The Quality Approach* and AFH 90-503, *The Process Improvement Guide*. The new handbook is titled AFH 90-502, *The Quality Approach*. You also told us you wanted to see more "how to" information on benchmarking, it's in here. Some of you wanted to see information on the Action Workout process, it's in the new edition also. Additionally, we've updated the information on the Air Force Core Values and modified the QAF Model by placing the core values at the center of the model, where they belong.

The "third edition" team charter also included a direction to make this book useful to everyone from the lowest ranking airman on the flightline to the wing commander. Hopefully, we succeeded. As with the previous editions, team members used the continuous improvement process—from identifying the improvement opportunity to planning for future editions—to match the product to your needs and

expectations.

Contents

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Quality Air Force

What is Quality Air Force?

Quality Air Force (QAF) is a leadership commitment and operating style that inspires trust, teamwork and continuous improvement everywhere in the Air Force. The QAF principles and techniques provide the tools needed to make those improvements. These concepts have a proven track record in the Air Force and in world-class organizations around the globe.

> ***"Quality is not a static description, but a dynamic process for an attitude of continuous improvement within the constraints of available resources. Quality does not stand alone, but is measured by its contribution to the Air Force mission."***
>
> ***Dr. Sheila E. Widnall***
> ***Secretary of the Air Force***

A quality-focused organization recognizes the need to improve and wisely adapts to meet changing operational demands. Faced with shrinking resources and a dynamic international environment, today's Air Force continues to undergo fundamental structural changes. It's just not logical to reshape the Air Force into a smaller version of the "Cold War" military; we must find innovative ways to improve the way we do business. With new, ever changing challenges facing our nation and our service in the coming years it is imperative that we constantly seek a better, faster and cheaper way to accomplish our mission. That's where Quality Air Force can help—allowing us to improve productivity and quality of life through the ingenuity and collective strength of us all.

Quality Air Force System

Quality Air Force is built on a foundation of leadership and is an integrated system of three components: quality focus, quality in daily operations and the improvement process. Quality focus identifies the priority issues. The improvement process focuses continuous improvement efforts as needed. Quality in daily operations applies QAF concepts to the workcenter. Finally, the Air Force core values—at the center of the model summarize the military profession.

QAF System Model

Leadership … is the foundation of the Quality Air Force system. Leaders set the vision, policies, priorities and strategies. Their responsibility is to foster an environment that inspires trust, teamwork and pride. Leaders maintain a customer focus*and* a systems perspective. They must not lose sight of their overall responsibilities. These responsibilities cannot be delegated. Therefore, senior leadership involvement is absolutely necessary to ensure successful implementation of quality principles.

"The difference between a Quality Air Force and just another organization ...is leadership."

Gen. Ronald R. Fogleman
USAF Chief of Staff

Quality Focus … includes strategic planning, senior-level guidance and a cultural implementation throughout the Air Force. Think of it as "the big picture" approach to quality, a top-to-bottom alignment of goals and objectives. Achieving this focus requires "buy-in" at all levels from front-line airmen to four- star generals. This can only happen when the ideas of people who best know the processes are solicited and incorporated into the strategic plan. Does everyone know the plans, strategies, goals and objectives? Do they understand how those plans and strategies relate to the mission? What about how their individual jobs contribute to the process? The replies to these questions may hold the key to your organizational success.

> ***"My personal philosophy is that the best outfits are those wherein a procedure is developed so that every man who has an idea on a particular subject may bring it forward without the slightest criticism or hesitation and argue for his point of view. He should not hang back because his idea may appear radical or because the bulk of the crowd may not agree with him."***
>
> ***Gen. Curtis E. Lemay***

Quality in Daily Operations … puts theory into practice. Tools and metrics are a part of the daily routine in a culture, where teamwork and continuous improvement are part of the job. Specialized education and training, customer-focused processes and customized evaluations help meet the needs of all commands. The QAF effort goes beyond installation or command boundaries. The new culture demands "common ground" so we can grow together.

Improvement Process … is a structured team environment and a disciplined approach allowing people to work together toward a shared objective. This is a working environment, enriched by empowerment, team participation and commitment. The ultimate goal is to find ways to work smarter, faster and cheaper.

Improving processes allows us to reduce costs, cycle times and man-hours. Results from the improvement process provide better products and services, stronger team and individual skills, open communication and a richer quality of life for all.

Values ... are certain ideals—core values—set the standard for our behavior, our service and our treatment of one another.

> ***"Integrity, service and excellence. Three simple words that epitomize the core of the military profession: the bedrock of integrity, fortified by service to our country, which in turn fuels the drive to excellence."***
>
> ***Dr. Shelia Widnall***
> ***Secretary of the Air Force***

Integrity First … is the foundation of trust, standing by your word and a commitment to honesty. Demonstrated integrity, in a high-risk aerospace environment is a life-essential element of every job, from filing work orders to launching combat sorties. It is doing the right thing when nobody is looking.

According to General Ronald R. Fogleman:

> The Air Force exists to fight and win wars—that's our core expertise. It's what allows us to be called professionals. We're entrusted with the security of our nation. The tools of our trade are lethal, and we engage in operations that involve risk to human life and untold national treasure. Because of what we do, our standards must be higher than those of society at large. The American public expects it of us and properly so. In the end, we earn the respect and trust of the American public because of the integrity that we demonstrate.

Service Before Self … is being willing to place the needs of the service above our own needs. Secretary of the Air Force Sheila E. Widnall said, "Selfless acts of courage and service fill our military history books. Someone once said 'There are no heroes; only ordinary men and women caught in extraordinary circumstances.' Our nation's medal of honor winners are perfect examples of what normal people can do when they place service before self."

Excellence in all We Do … across all daily activities is directly or indirectly related to mission accomplishment. In the military, we can't afford to fail in achieving excellence in all we do. General Ronald R. Fogleman states, "To excel is a moral obligation for members of a professional military force. The line between incompetence and immorality is a thinner line in the military than any other calling."

Education and Training Strategy

Education and training are essential to implementing quality. Today's quality training is designed so an individual will receive the right training at the right time. With this in mind, they will receive the basic fundamentals of quality concepts through the professional military education system. Base level training will reinforce principles and concepts with hands-on training via just-in-time courses. For example, if you are appointed to be a team leader, the base will provide training on the roles and responsibilities at the appropriate time.

Air Force Awards

The Air Force recognizes that while education is important and leadership is vital, the real key to continuous improvement lies in the hands of the people actually accomplishing the mission out on the flightline, in the support office or in the cockpit . Award programs should recognize accomplishments consistent with the values and direction of the organization and support overall A ir Force objectives. Many organizations use local reward and recognition programs that publicize a team's progress in the quality effort while publicly praising those involved. The Air Force has two programs: the Secretary of the Air Force Unit Quality Award and the Chief of Staff of the Air Force Team Excellence Award.

The **Secretary of the Air Force Unit Quality Award** is based on the QAF criteria. The award recognizes organizations for outstanding mission accomplishment and implementation of a quality culture. The Air National Guard, Air Force Reserve, Headquarters Air Force and each major command are invited to nominate one unit for the award. The best practices of all the finalists are published in the *Profiles in Excellence* to share their success with other Air Force units.

The **Chief of Staff of the Air Force Team Excellence Award** recognizes outstanding team performance, promotes QAF awareness and implementation, emphasizes teamwork, results, rewards excellence and shares best practices. The Air Force Reserve, Air National Guard, Headquarters Air Force and the major commands are each invited to nominate two teams for this award. A team of experts scores the application packages based on results, overall Air Force impact and a 15-minute presentation of the team's story.

Quality Air Force Criteria

When you're planning a long journey, you need a roadmap. The Air Force roadmap comes from the Air Force senior leadership and includes the QAF Criteria. The criteria are based on the Malcolm Baldrige National Quality Award (MBNQA).

According to Mr. Greg Watson, the senior 1996 Secretary of the Air Force Unit Quality Award examiner:

> Today, the Air Force is at a crossroads in its process of seeking maturity in its processes. The best units are at the point where they must transition from training and the decreed use of scientific methods, analytical tools, teamwork and process management to the point where these methods have become a natural part of its behaviors, actions and methods. The true test of leadership for the entire Air Force will be its ability to navigate safely beyond this current position of excellence in the top units to the ability to sustain systematic organizational improvement efforts across all units, not just the award nominees.

The criteria provide the framework to achieve these systematic improvements. The criteria assess seven interrelated and essential ingredients of every successful organization. (See chapter 6 for a complete explanation of the assessment system.)

Government Performance and Results Act

The 103rd Congress enacted the Government Performance and Results Act (GPRA) into public law (Law 103-62) in 1993. The intent of GPRA is to bring about fundamental changes in how the government operates. Air Force leadership, fulfill ing the spirit and letter of the law has shown its commitment through policy guidance and support for training at all levels .

The purpose of the GPRA is to:

1. *Improve confidence* ... of the American people in the capability of federal government, by systematically holding federal agencies accountable for achieving program results.

2. *Initiate program performance* ... with a series of pilot projects in setting program goals, measuring performance against these goals and reporting publicly on their progress.

3. *Improve federal program effectiveness* ... and public accountability by promoting a new focus on results, service quality and customer satisfaction.

4. *Help managers improve service delivery* ... requiring they plan for meeting program objectives and by providing them with information about program results and service quality.

5. *Improve congressional decision making* ... by providing objective information on achieving statutory objectives and on relative effectiveness and efficiency of federal programs and spending.

6. *Improve internal management* ... of the federal government by requiring agencies to submit:

    a. strategic plans—beginning September 1996 covering a period of five years

    b. annual performance plans—beginning Fiscal Year 1997

c. performance reports—beginning Fiscal Year 1998

d. The GPRA requires structured strategic planning and measurement systems that indicate how well agencies are achieving results based on their strategic performance plans. It shifts the focus to outcomes—how the public is affected by the program.

Two fundamentals key to the success of GPRA are accountability and flexibility. Managers cannot be held accountable for results unless they are empowered with the authority and discretion needed to accomplish results. The GPRA goal is an effective, efficient and results-based government.

2

Leadership

Quality Leadership

Quality is not a new way of conducting business or a new management tool. Military leaders of many eras have recognized the value of quality leadership.

> ***"Never tell people how to do things. Tell them what to do and they will surprise you with their ingenuity."***
>
> ***Gen. George S. Patton, Jr.***
> ***United States Army***

However, the terminology of quality is new and evolving. Leaders must communicate quality through actions, attitudes and behaviors and by clearly defining and communicating the mission and vision.

The Air Force Mission

> ***"To defend the United States through control and exploitation of air and space."***

A mission describes the task you face, the forces you bring to the fight, what you hope to achieve and the medium in which you operate. It is ongoing, enduring and symbolizes goals that will stand for long periods of time.

The Air Force Vision

"Air Force people building the world's most respected air and space force...global power and reach for America."

It's more than a slogan—a vision is a picture of the future. While the mission describes the current tasks, the vision determines the direction and helps you focus.

Principles

The core values of—integrity first, service before self and excellence in all we do—are supported by a set of principles. They're similar to a creed and provide a roadmap to help reach our goals. Here's a look at the QAF principles:

Leadership involvement ... sets the pace for our journey by establishing the vision, policies, priorities and strategies. Leaders communicate these by creating an environment that supports trust, teamwork, risk taking, initiative, reward and continuous improvement. Leaders initiate and sustain quality in the culture, a responsibility that cannot be delegated.

Dedication to mission ... is reflected in all we do as a team. No matter what the role—from flightline to family care—every person is critical to achieving "global power and reach" for America.

Respect for the individual ... happens as we recognize everyone's skills and contributions. Rank and level of responsibility shouldn't be the measure for respect. Success comes when you understand and appreciate each person's contributions to the team.

Decentralized organization ... breaks down functional walls and eliminates layers of bureaucracy. By aligning an organization to support critical processes, both customer and stakeholder prosper. Decentralizing organizations returns decision-making authority to the appropriate level.

Empowerment ... is one of the most misunderstood concepts. Some leaders understand empowerment as a surrender of power to subordinates. Not true! This isn't about power—it's about giving people the tools they need to do their jobs. Leaders who have learned to use empowerment find their roles enhanced—not weakened. The goal is to create an environment in which properly trained subordinates can continually improve the organization. This encourages innovation and risk taking. However, empowerment is a two-way street. Once a leader empowers an individual, they must accept the responsibility and accountability that comes with empowerment.

Management by fact ... uses realistic measures to help indicate when, where and how to improve the most important processes. Data-driven decisions help identify smarter, more productive ways to accomplish the mission.

Operating Style

Create a working environment that inspires trust, teamwork and pride. Trust and teamwork instill pride and a sense of mission ownership.

Delegate responsibility and authority. Give people the tools, training and guidance they need and they will accept accountability for results.

Set goals, measure progress and reward performance. Develop and communicate goals that support the Air Force vision and align the objectives—from top to bottom. Then measure results, evaluate progress and celebrate success.

Give everyone a stake in the outcome. Empower people who own the processes and products to ensure the acceptance of responsibility and increased productivity.

Strive for continuous improvement. Challenge the concept of "business as usual." Understand customers' needs and requirements, and learn new ways to do jobs smarter and better.

QAF Roles

Senior Leader Roles

Senior leaders set the pace of an organization by identifying the values through strategic planning. In addition to planning for the future, senior leaders talk with customers, focus on work to complement the Air Force vision and measure significant objectives necessary to accomplish the goals. They know the benefit of creating a short-term plan (12-24 months) as well as a long-term plan (over three years). These plans help keep the organization on track. Turnover in leadership shouldn't change these plans, however it's realistic to expect the inevitable mid-course corrections.

Senior leaders can better plan for the future by listening to feedback from the workforce and addressing individual and group needs. Feedback through strong, positive communication helps leaders and workers better understand the organization's processes. Therefore, senior leaders must create a cooperative environment by implementing policies and procedures that *enable* and *energize* the work force.

Mid-level Leader Roles

Mid-level leaders provide training and resources, and facilitate continuous process improvement. Everything they do is designed to support organizational goals and objectives. From measuring work processes to reviewing objectives, these people literally put QAF theories to the test in the everyday workcenters. They also make sure information on key issues moves smoothly along the chain of command.

Individual Roles

Individuals who are the process experts are vital to the continuous improvement process. Everyone must know the strategic goals and critical processes that best support mission accomplishment and customer requirements. Then they can work to understand each person's contribution to those processes.

Front-line workers probably know better than anyone else what's required to satisfy the customer. However, they can't help meet mission goals if they don't understand the process. They must be taught the basics, included in discussions that affect processes such as estimating capability and developing metrics. It's important to remember that process workers are essential in identifying key issues to successfully execute the strategic plan.

> ***"Trust men and they will be true to you; trust them greatly, and they will show themselves great."***
>
> ***Ralph Waldo Emerson***

Quality Advisor Roles

Commanders play the lead role in implementing quality in a unit. However, they will probably need assistance in bringing quality into their day-to-day operations. The quality advisor assists and

advises the commander in the use of QAF principles, concepts, tools and techniques to improve organizational, team and individual performance. The quality advisor helps the commander build an environment that results in trust, teamwork and continuous improvement. According to David W. Hutton, in *The Change Agents' Handbook*, to be most successful the quality advisor needs to:

- Understand the leader's priorities and preference
- Establish a relationship of mutual trust and respect
- Assist the leader in understanding quality in practice

Most importantly, the quality advisor must have the commander's full support.

Typically a quality advisor fulfills four roles —architect, trainer, coach and consultant.

An architect builds the support system used to institutionalize a cultural change. This system consists of at least the following: senior-leader council, quality working groups, education and training efforts, teams, subordinate unit quality advisors, instructors and an administrative support structure. The commander is the foundation of the system and the quality advisor plans, builds and implements this basic system within the organization.

An important duty of the quality advisor is training management. The quality advisor assesses training needs, develops budgets and resource priorities, schedules and organizes training and establishes a plan to reinforce training in an on-the-job environment.

An extremely important role is that of coach. The commander is the single most important public figure in the organization. The actions of the commander are watched very closely. This is one area where the quality advisor may have a significant impact. Like

a football or track coach, the quality advisor can observe the leader's performance and make recommendations to encourage behaviors that support quality in the organization, pinpoint behaviors that are counter to the quality culture and give positive and developmental feedback (Werner and Lynch, 94).

A quality advisor is also a consultant. The quality advisor recommends, coaches, persuades, confronts and solves problems depending on the situation. The quality advisor's role is to facilitate for leadership so they can plan, develop, deploy and revise the strategic plan and its link to continuous improvement.

3

Quality Focus

Phases of Quality Focus

A quality organization must start with a sound systematic plan. Planning is a leadership-driven cooperative effort between the leadership team and the organization. Establishing a strong quality focus requires substantial time and effort from the leadership team as they formulate, deploy, implement and review their vision, mission and plans.

Formulation Phase ... consists of defining the mission, vision, values and developing goals and objectives from a macro or "system" perspective. Envision an organization that fulfills its mission, exceeds customer needs and expectations that may constantly be changing. The ability to meet those demands depends on actively listening and communicating with customers regularly to help tailor performance.

Start setting customer-driven goals and objectives by answering the following questions. Who are your key customers? What major product or service characteristics (timeliness, accuracy, reliability, etc.) are they most concerned about? Can you and your customers agree on indicators to how well you're doing in those areas? Once you reach agreement, monitor those indicators and use the information to identify improvement. Finally, develop supporting action, human resource and budget plans to move you toward the goals and vision.

Deployment Phase ... builds a support structure to integrate the mission, vision, values and goals throughout the organization. It's important that communication be two-way to ensure understanding and "buy-in." A technique known as "catchball" is very useful to achieve wide scale deployment. Catchball is a give-and-take

dialogue within the organization—keep it going until everyone understands the desired focus of the organization. Each level of the organization should, in turn, develop goals, objectives and action plans to support the overall goals. They will also need functional plans while monitoring and tracking their processes and product and service indicators to ensure quality consistently meets customer requirements and performance goals.

Implementation Phase ... takes a common-sense approach to implementation; focus on the most important and don't expect immediate changes or 100% success. Natural working groups will monitor the action plans and incrementally improve processes. Other teams may need to identify improvements and breakthroughs in a few selected areas critical to organizational success.

Review Phase ... compares your progress to the original plan. Do your system indicators show you're meeting customer requirements and improving performance? Do you have a tracking system for your action plans and their results? Evaluate your overall planning and implementation process, expanding your improvement efforts.

Strategic Planning Process

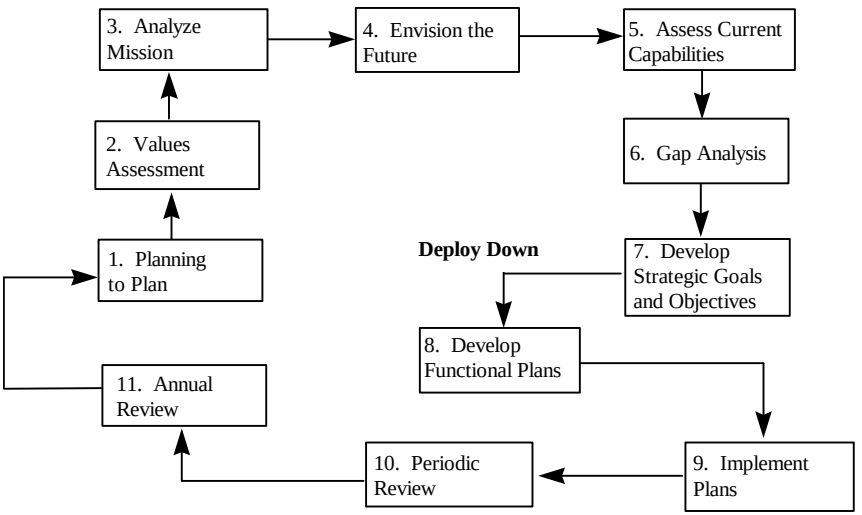
In order to effectively implement the four elements of quality focus you'll need a sound, systematic process. The process should help review steps taken and search for ways to identify additional improvement opportunities. There are many models and approaches from which to choose. The Strategic Planning Model developed by AFQI is one that provides a sound, systematic and integrated process for achieving organization-wide quality focus.

Quality Air Force strategic planning is designed to provide a structured and more detailed approach to accomplishing the activities involved in the four phases of quality focus. The basic elements include the mission, vision, values, goals, objectives and

action plans. In addition, metrics and indicators track performance and a review indicates progress. There are plenty of planning processes to choose from, many that are very similar. Whatever process you choose, make sure it is systematic and addresses the four phases of quality focus.

Here's an overview of the Strategic Planning Model developed by AFQI. Although the model provides a recommended order of activities, strategic planning requires flexibility and often the simultaneous accomplishment of multiple activities (formulation and deployment, deployment and implementation, etc.). Back-tracking and overlapping between steps are common as new factors are continually introduced.

Strategic Planning Model



Step 1: Planning to Plan—Leaders must first be willing to commit the time and other resources necessary for an effective planning process. Then the following must be identified: dedicated team members, permanent facilitators, meeting schedules and administrative support. A well-planned approach with milestones and a target date for completion will help the team stay on track. Without strong trust, teamwork and commitment, the planning process is likely to fail. Therefore, a commitment to the process and strong working relationship between the leadership team and the organization is essential.

Step 2: Values Assessment—The values driving behavior define the organizational culture. Values mark the boundaries of any planning process and should serve as a baseline for actions and decision-making. Leadership should first assess current values driving organizational behavior. Then it can determine which values and behaviors to reinforce. Since people often base behavior on *perceived values* it is critical to ensure their perceptions reflect Air Force and organizational values. Use metrics to monitor these behaviors. Finally, leadership must communicate, encourage and reinforce the desired values and related behaviors to integrate them into the organizational culture.

Step 3: Analyze Mission—The entire planning team as well as the rest of the organization completely understand the mission. The team should create a mission statement that concisely expresses the reason for existence. Key elements include the organization's purpose, who it serves, how and why. The most effective mission statements are easily recalled and provide direction and motivation for the organization. When analyzing the mission, it's important to conduct an ongoing environmental scan.

This includes: identifying and analyzing factors that impact the mission; identifying customers, suppliers and their requirements; defining key result areas and defining key processes. Here's a look at each of these:

- *Identify factors and drivers that impact the mission.* Anticipate and understand internal and external environmental factors (political, budgetary, technology, etc.) likely to impact your strategic planning. Consider the factors identified in the environmental scan with the products generated by each step of the model to validate the strategic plan.

- *Identify customers, suppliers and their requirements.* Every customer (internal or external) has specific needs and requirements that include a set of quality characteristics (i.e. timeliness, accuracy, convenience, dependability, etc.). Planning team members must identify these requirements as well as suppliers' needs and requirements. (A supplier is anyone who provides materials, service or information to the organization.) Fully understanding who the organization's key customers and suppliers are helps identify the requirements. Finally, customers and suppliers should then validate their requirements before the team finalizes the mission.

- *Define key result areas.* The major categories of customer requirements critical to organizational success (e.g. responsive airlift, dependable air refueling, combat ready equipment and people, etc.)? Usually organizations have anywhere from six to twelve key result areas. Determine customer expectations associated with each key result area, then compare them with organizational values to see if they are congruent. Establish priorities based on this relationship.

- *Define key processes.* Key processes are system-level or macro processes that typically cross functional boundaries. Normally, one to four key processes support each key result area. Sometimes a key process will support two or more key result areas. The measurements of these key processes form the basis of a sound metrics system.

Step 4: Envision the Future—Envisioning the future makes strategic planning proactive rather than reactive in nature. Without a vision of the future, it's hard to plan for anything except sustainment. As Erich Fromm pointed out, "The best way to predict your future is to create it." A planning team should visualize the future, develop possible scenarios and plan the direction of the organization. From there, you can develop a realistic vision; followed by a vision statement, organizational goals, objectives and metrics.

Step 5: Assess Current Capabilities—Evaluate key processes to determine if they meet current and future customer requirements. Use this assessment as a baseline for future improvement, as well as the gap analysis. Measure current capabilities by referring to recent inspection results and other existing data, or conducting a unit self assessment. Another way to assess your current capabilities is to compare your organization against external benchmarks.

Step 6: Gap Analysis—The gap analysis identifies the progress required to move the organization from its current capabilities to its desired future state. If the progress required is minimal, perhaps the future vision isn't ambitious enough. If the gap seems overwhelming the future vision may be unrealistic. Benchmarking with other internal and external organizations can help identify a realistic gap. From the gap analysis, identify critical issues facing the organization in relation to the key result areas and capabilities for near- and long-term planning.

Step 7: Develop Strategic Goals and Objectives—Tie strategic goals to the vision and strategies for overcoming the critical issues. Develop goals and objectives to bridge the gap between current capability and the vision. The strategic goals and objectives form the basis for the action plans. Prioritize and communicate this information to collect and incorporate the feedback. The feedback helps determine if goals and objectives are feasible and helps gain support and commitment from unit personnel.

Step 8: Develop Action Plans—At this point the planning team commissions working groups to develop action plans. Senior leadership should take an active role in developing action plans. The action plans must address potential problem areas; consider the cross-functional impact of the actions and include "what if" provisions in case primary plans can't be executed. To develop action plans define the subprocesses and tasks that align with and support key processes in the organization. Develop methods to measure the subprocesses. An important reminder—before implementing the action plans, give the senior planning team a chance to review them for cross-functional integration, alignment and system optimization.

Step 9: Implement Plans—Functional, process action and developmental teams and natural working groups all carryout the plans to move the organization closer to its vision. Senior-leader oversight and review are critical for effective implementation.

Step 10: Periodic Review—Take some time each month to review action plans and their progress. Use metric data to assess progress and communicate the results throughout the organization.

Step 11: Annual Review—Annually, the planning team should review the overall Strategic Plan. Input metric data and the periodic review results into the next planning cycle and review the strategic planning process for continuous improvement.

4

Quality in Daily Operations

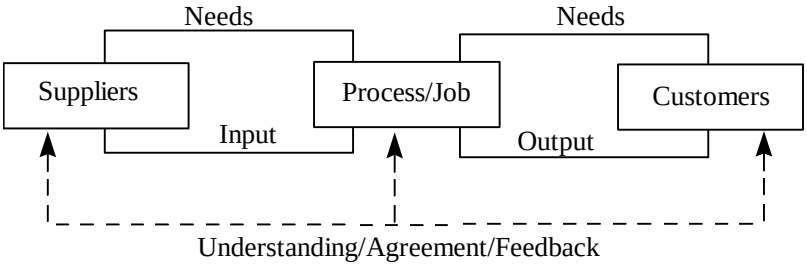
Definition

Quality in daily operations (QDO) implies repeatedly doing the best at a job according to internal and external evaluation criteria. You should be able to determine whether you are doing a good job regardless of the frequency or duration of your tasks. In order to determine this, you must know how your job is part of a process that supports the larger Air Force mission. To do a good job in daily operations look at the following components: customer and suppliers interaction, metrics and an assessment process.

Customer/Supplier Model

This model is a simple illustration that demonstrates the flow of inputs and outputs through a process.

Customer/Supplier Model



Using the model, ask the following questions about the products and services you provide:

- What do you need from your suppliers (people or processes that provide tools, equipment, raw materials, questions, information, etc.) to make your process work?
- What type of feedback could you provide your suppliers to benefit the process?
- Is your part of the process effective and efficient?
- What products or services do you provide customers?
- What type of feedback is needed to meet customer expectations?

Metrics

A metric is a meaningful measurement taken over a period of time that communicates vital information about a process or activity, leading to fact-based decisions. There are many things to measure to help better understand systems and processes—but it's simply not feasible to measure them all. Instead, select the critical few metrics for process and monitor them. The following are eight characteristics of a good metric according to The Metrics Handbook, AFMC Pamphlet 90-102:

- Meaningful to the customer
- Simple, understandable, logical and repeatable
- Shows a trend
- Clearly defined
- Data that's economical to collect
- Timely
- Drives appropriate action
- Shows how organizational goals and objectives are being met through tasks and processes

The mission, vision, goals and objectives of the organization should be developed first in order to manage daily operations according to metrics. Remember: evaluate systems and processes—not people!

Sources of Metrics

Each organization may already have measures available for the metrics you need. Using or modifying available information saves time and duplication of effort. Air Force agencies have extensive databases on budgets, training, maintenance, personnel information, etc. In addition, other organizations that do similar work may have helpful ideas (see Benchmarking in Chapter 5).

Examples of Metrics

Most successful organizations are able to continually produce quality products and services very quickly. They have processes in place that allow workers to meet high standards in their products and services. What metrics might organizations use to evaluate themselves to ensure success? How is customer satisfaction translated into metrics that can guide and inspire their individual workers? The following are a few examples of metrics that might be worthwhile in some organizations:

1. An "outcome/customer satisfaction" metric ... such as the percentage of customers who respond "excellent service provided" on random surveys over a pre-determined period of time. The goal would be to keep the percentage high. This survey could also help identify specific areas for improvement.

2. A “process” metric ... such as percentage return rate would measure the number of defective products versus the number produced. The goal would be to stabilize the percentage at a small number. The nature of the defects could be displayed in a pareto chart to identify problem areas in processes.
3. A “system” metric ... such as time spent in an organization on internal processes versus time spent interfacing with the customer.
4. A “supplier” metric ... such as percentage of items that arrive late. The results could be used to negotiate a better arrangement with suppliers, find a new supplier or decide no changes are necessary.

When developing and managing a metric, be sure to communicate its purpose, the results obtained, decisions made and actions taken based on the metric. Also remember that what is measured will drive behavior in the organization. If measurements are made irrationally, erratically, without a clear purpose or with negligence, expect similar behavior from the organization.

Assessment Process

Metrics measure processes over time. An assessment method is needed to measure the success of the QAF system. To help track your progress, the QAF roadmap includes assessment and awards programs. You can use the QAF Criteria to measure your progress. There are many formal assessment processes that the AF uses to evaluate organizations. These assessments include IG inspections, operational readiness inspections, unit self assessments, award and recognition programs such as the Secretary of the Air Force Unit Quality Award and the Chief of Staff Team Excellence Award (see Chapters 1 and 6 for more detailed explanations). These assessment processes incorporate metrics and may be of assistance in developing metrics in your unit.

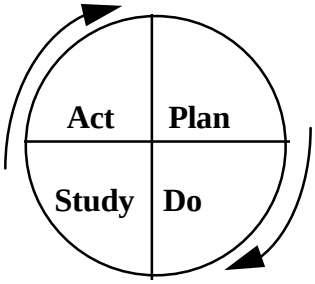
5

Improvement Process

Once you have defined your metrics and begun to achieve maximum performance in your daily operations you will find opportunities to improve your processes. Four approaches to exploiting these opportunities are the continuous improvement process (CIP), action workout, benchmarking, and reengineering. The concept of process improvement is based on the Shewhart cycle.

Shewhart Cycle

The Shewhart cycle, also referred to as the Ishikawa Circle or Deming Wheel, is a systematic approach to achieving continuous improvement. The approach involves repetition and is often represented graphically as a circle. The circle has four quadrants: plan, do, study and act (PDSA).



Plan—Study the process flow and any existing data. Formulate possible improvements and experiments or decide on methods to gather data. When working with a new process, be willing to concede additional time to this quadrant to identify and think about the processes.

Do—Implement the improvement effort you've planned using a small-scale test. Working from too large a base of change can make it difficult to assess the effects of the change. Train the people responsible for implementation. They need to know what the goal of this change is, and how they impact the implementation process.

Study¾ Measure the results of the improvement effort. Analyze the data collected. Study the results to see if the process was improved. This quadrant gives you the chance to see if you measured the right things and can also give you helpful clues about variables.

Act¾ If the result was a clear improvement, the team should agree to make the change permanent, standardizing and documenting all actions. If the results weren't successful, identify the cause then go back to the "plan" quadrant and start over again with the newly acquired knowledge.

Teams in the Work Place

One of the most effective ways to use the PDSA cycle is in a team setting. Teams are a critical part of the QAF culture. They improve existing processes, solve problems or develop new plans or procedures. Team members benefit from a wide range of ideas and an increased knowledge of the system. Four of the more common types of teams are tiger teams, process action teams, developmental teams and natural working groups. The teams can include workers from different organizations, but everyone must share a given process.

Tiger Teams ... are formed by senior leadership to address symptoms of a specific problem. High visibility and priority are two important characteristics of tiger teams. Members are normally selected for their expertise in the problem area. Tiger teams normally meet for a short time and promptly disband after they alleviate the symptom or complete the task. They are of limited utility, formed only to address symptoms—not develop long term solutions.

Process Action Teams ... are formed to improve an existing process. The process owner must clearly define the scope of activities and establish the duration of the task. Team members should have a vested interest in improving a process. They should be trained in group dynamics, the continuous improvement process model and basic quality tools.

Developmental Teams ... are formed to design new processes or projects. Members do not have to be experts in the tasks being developed. They may need training in the use of basic quality tools and may or may not be chartered.

Natural Working Groups ... typically work with a common desire to continually improve shared work processes. These members participate in the process and have a vested interest in its success or failure. Decisions regarding improvement efforts rely upon data collected relative to the process. By continually measuring the process, team members can be responsive to changes.

Self-Directed Work Teams ... can evolve from natural working groups. Members working closely together in a work unit eventually gain a significant understanding of their work processes and the results produced. Because they also know their organization's mission, goals and operating guidelines they can analyze the processes and develop and monitor useful measures to identify improvement opportunities. They trust one another and have refined interpersonal skills that contribute to reducing negative

conflict and achieving the ultimate goal of delivering the product or service. A fully-functioning self-directed work team actually directs its own work. This high-performing team requires support from supervisors and leaders who must maintain an environment in which the team can excel.

Basic Tools and Techniques

Use basic quality tools to work through the continuous improvement process. These tools can be grouped into four categories: generating ideas, making decisions, analyzing problems and analyzing data. They are described below and discussed in greater detail in Appendix A; the Process Improvement Guide.

Generating ideas—Get your team thinking and working together with "idea starters." These tools work well for teams *or* individuals and can be adapted to suit changing purposes. Some examples are brainstorming, mental imaging and the "five whys."

Making decisions—Organize the ideas generated and aim for consensus or a "win-win" decision. Tools to help teams make decisions include nominal group technique, pairwise ranking, multivoting and benchmarking.

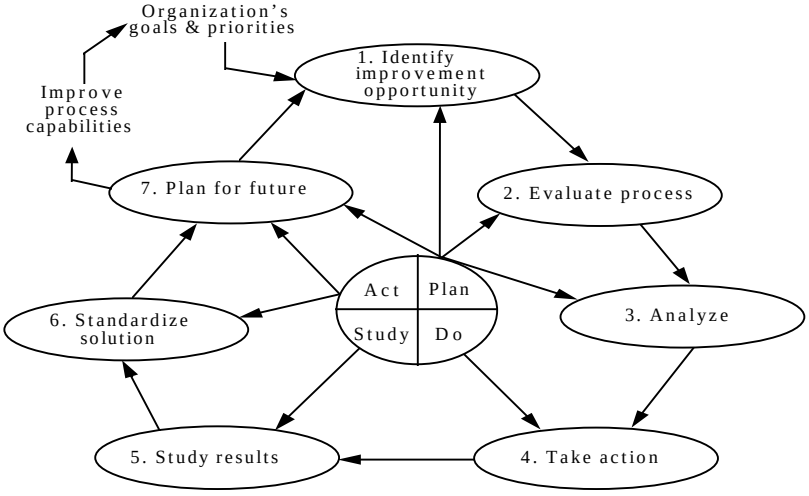
Analyzing problems—Searching for the root cause of problems can be challenging—whether analyzing just one part or the entire process. Some helpful tools to use are cause-and-effect diagrams, flowcharts, pareto charts and thematic content analysis.

Analyzing data—Throughout improvement efforts, a lot of data will surface for analysis. Some tools to use for analyzing data include: check-sheets, histograms, run charts, box plots, control charts and process capabilities ratios.

Continuous Improvement Process

The continuous improvement process (CIP) is a systematic approach to planing, sequencing and implementing improvement efforts. It is not the *only* process improvement model or method, but it is a very comprehensive improvement process based on the Shewhart cycle. Additionally, CIP provides a common language and methodology for all Air Force members to better understand the improvement effort.

CIP Model



Step 1: Identify Improvement Opportunity

Select the appropriate process for improvement that impacts the organization's mission and is linked to its key processes. This helps ensure the most return on investment (ROI) for the team's efforts. Establish a logical pattern or framework to lead the team through the improvement process. Develop indicators, such as graphs or control charts, to accurately display and help visualize the

need for improvement. Remember to narrow the focus to a specific process; keep the improvement efforts within the team's span of control.

Checkpoints:

- ü Identify the organization's key processes
- ü Ensure everyone understands why the process was selected for improvement and its relationship to the strategic plan
- ü Identify customer-defined critical success factors
- ü Develop a macro-process flowchart
- ü Prioritize candidate processes
- ü Identify the process to improve
- ü Identify process owner, customers, suppliers and stakeholders
- ü Identify customer requirements
- ü Establish indicators that will measure process performance
- ü Develop schedule for completing CIP and leadership reviews

Step 2: Evaluate the Process

Select an improvement opportunity and focus on the problems in close detail. Collect and interpret data relating to the process and identify a specific issue to tackle. Remember, the word 'problem' describes any discrepancy between the *current* and *desired* state of a process.

Checkpoints:

- ü Develop "as is" flowchart to task level
- ü Identify process measurement relevant to customers then collect the data
- ü Stratify the problem to a specific level for analysis
- ü Identify the most significant part of the problem
- ü Validate customer requirements against process capabilities
- ü Ensure the problem statement addresses the gap between the desired state and the actual state of the process
- ü Establish the target for improvement (use data)

Step 3: Analyze

To identify and verify the root causes of the problem use analytical tools to explore the data. Do not focus on symptoms! Analysis can help avoid discussing symptoms while identifying areas that need more information. Whether focusing on a single stage or an entire process, a careful analysis can help you succeed.

Checkpoints:

- Perform cause-and-effect analysis of the problem
- Analyze potential root causes
- Select the root cause that has the greatest probable impact
- Verify the root causes (use data)

Step 4: Take Action

Plan and implement actions that correct root causes. The team can propose improvements by using an action plan matrix to identify specific methods to use in attacking root causes. The action plan should address *what, who, how* and *when* plus identify the resources needed. The methods should be feasible, effective and cost beneficial.

Checkpoints:

- Develop and evaluate possible actions
- Ensure the actions are cost-beneficial
- Develop an action plan
- Test actions (if possible) before fully implementing them
- Get the cooperation and approval needed
- Implement the action plan

Step 5: Study Results

Confirm that the actions taken achieved their target results. It's important to understand *why* the target was or wasn't met. If the actions were not effective, additional actions may have to be implemented.

Checkpoints:

- ü Confirm the indicator was the same one used to identify the process
- ü Determine if the action results met or exceeded the target
- ü Discuss why the target was or wasn't met
- ü If the target wasn't met, confirm additional actions

Step 6: Standardize Solution

Maintain the improved level of performance. Integrate the team's improvement efforts into the organization; make improvements a regular part of daily operations. A control system can help by outlining the process, tasks involved, improvement efforts and targets.

Checkpoints:

- ü Publish revised methods and procedures
- ü Conduct training on new processes
- ü Create periodic process review points
- ü Consider areas for replication

Step 7: Plan for Future

Plan what to do with remaining problems and evaluate the team's effectiveness. The improvement process allows the team the opportunity to review the work accomplished, address remaining issues and evaluate effectiveness. Additionally, the team can review lessons learned in problem-solving, interpersonal communications and group dynamics.

Checkpoints:

- ü Analyze and evaluate any remaining issues
- ü Plan any future actions necessary
- ü Evaluate the team's problem-solving skills and their effectiveness

QAF Tools

There are a number of tools that can be effectively used in each of the 7-steps of the CIP. Although some of the tools work better in one area than another, it is up to each team to choose based on its "comfort level" with each tool. A skilled facilitator can help determine the tools a team should use.

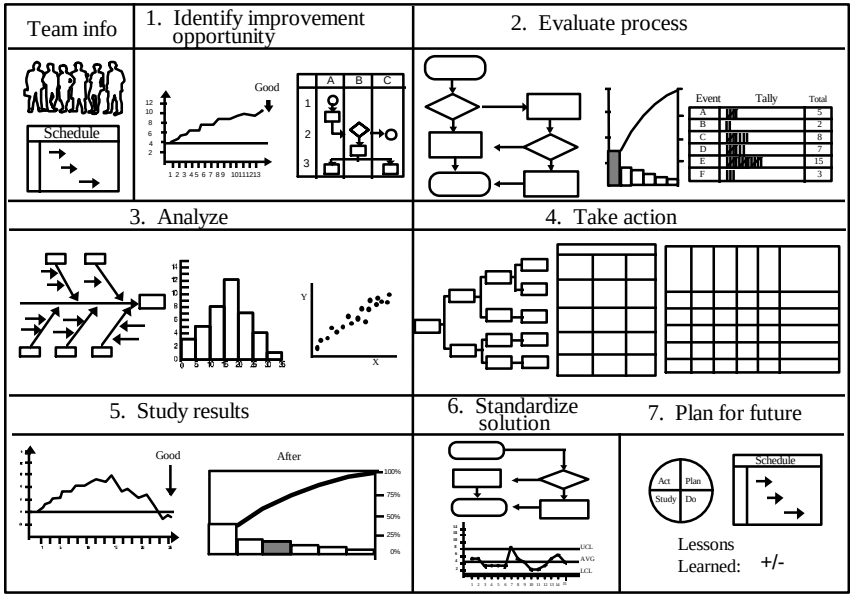
The Continuous Improvement Storyboard

Storyboards visually and logically present the appropriate steps in a plan or task. As an alternative to a lengthy narrative, "storyboarding" captures and tracks basic ideas, plans, activities and process actions. This technique is applicable to a wide range of process improvement or planning activities and requires minimal resources, materials and equipment.

Storyboards are usually visually appealing in their layout and design; they stimulate the reader's imagination. (Creating a storyboard can be a team building exercise in itself!) Another useful consequence of storyboards is the immediate feedback received. Ideas, suggestions and constructive criticism from coworkers not directly involved on the team can be posted using sticky-back notes. Additionally, they aid in documenting the team's work and are an excellent briefing tool.

Make the storyboard as simple—or as complicated—as you like. Get the team involved in selecting the storyboard it plans to use. Personalize the storyboard with team members' names or use a group photo. A sample storyboard is provided below.

Storyboard



Action Workout

An Action Workout (AWO) is a rapid, concentrated, high-energy, team effort to make dramatic productivity improvements in any organization.

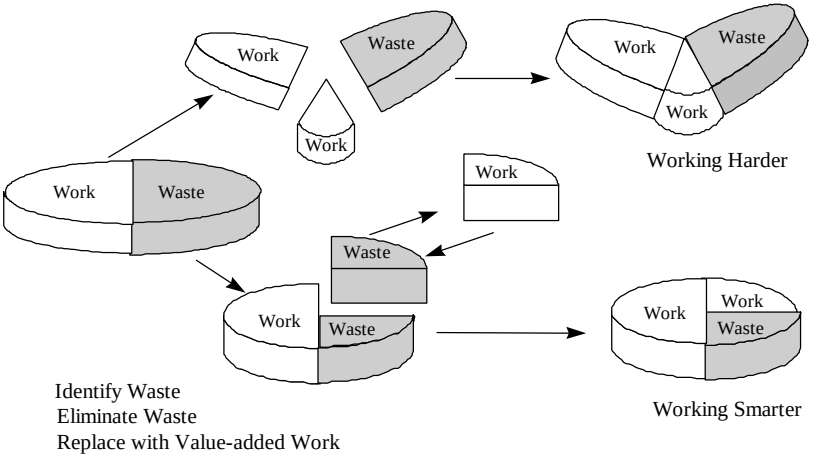
The AWO is driven by an urgent need to improve a process. Units can identify an AWO candidate through their Unit Self Assessment process or functional managers for systemic problems.

An AWO is designed to eliminate non-value added work and to reduce cost, work-hours (not personnel) and cycle times of key processes.

You can apply the AWO techniques to identify non-value-added work and waste. Some tools used in AWO include: video taping (to document work practices); using of visual controls; brainstorming; trystorming (going out and actually trying the new ideas rather than debating issues); process mapping; and modeling and simulation (if available). These basic tools and techniques produce significant results when team members apply them in a barrier-free environment that allows for a free flow of ideas.

Action Workout—the Human

Working Harder vs Working Smarter



Work Content

The diagram above depicts two distinct options to take in approaching daily work. Most work usually consists of productive activity and significant amounts of waste. However, when faced with additional work, we often take the path depicted by the top

arrow and cram the extra work into what is an already very busy and wasteful day. Consequently, this approach leads to longer days, additional shifts, requests for more personnel, etc., because systemic waste is never addressed. The path shown by the lower arrow is the ideal path to take. Process owners and stakeholders must determine what is necessary to eliminate waste in order to work smarter, not harder. This approach creates "space" for increased work capacity, multi-skilled workers and recovery time.

There are three classifications of work content: (1) value-added, (2) non-value-added, and (3) queue or wait time.

Value-added … activities are those tasks the customer is willing to pay for that affects the form, fit, or function of the product. "Compliance tasks" typically fall into this category. Usually less than 10% of any process is truly value-added. Teams should not look for "short-cuts" but for more efficient ways (reduce non-value-added steps) to get the job done while maintaining safety and conformance standards. Units should first attempt to creatively re-engineer a process and remove non-value-added rather than buy newer and faster equipment.

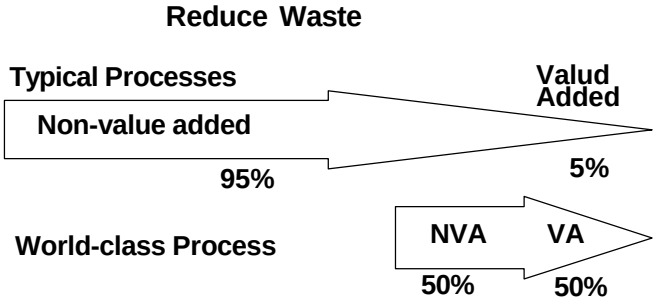


Figure - Waste Elimination

Non-value-added … increase the time, resources required and costs of products and services while not benefiting the product or customer. For example, walking across a shop floor to get a tool is non-value-added activity. In most cases, the tools should be located where workers accomplish the tasks. Often, leaders can eliminate non-value-added steps by "multi-skilling" their people. For example, calling a flight line specialist to perform a task in a "back-shop" is non-value-added if shop chiefs can adequately train their own people to do the task. Multi-skilling allows workers to remain in their primary work centers while reducing "wait" time. Teams should eliminate non-value-added activities or activities that add cost or require additional resources.

Queue time occurs when people cannot complete their work because other products being produced, maintained or repaired are already ahead of them in the system. For example, a worker who is inspecting an engine part can only safely inspect one engine part at a time. If other workers send four engine parts at a time, they add "queue time" to the process since the inspector will not get to work on the other three engine parts until the first inspection is complete. Thus, it makes more sense for the entire team to process one engine part at a time while sequentially completing the tasks. **Waiting** time is another form of process delay. You cannot eliminate all of the waiting time from the system. However, workers should not have to wait for material deliveries or for machine set-up periods. Team members should find ways to avoid waiting period whenever possible.

Types of Waste

Teams need to figure out what tasks must be accomplished to get the job done while meeting customer requirements. Inherently, there are "non-value-added" activities associated with normal work. These non-value-added steps typically fall into one of the following categories of waste.

Production Waste

- Over production—producing more than needed or faster than needed
- Correction/rework—repair of product or service not meeting customer expectations
- Motion—movement that does not directly add value to the product or service
- Processing—work or effort that adds no value to the user/customer
- Inventory—materials exceeding what is required to work productively via standard operations
- Transportation Waiting—people waiting for work or work waiting in batches for people

Administrative Waste

- Unnecessary approval
- Batch processing
- Multiple/manual systems
- Multiple hand-offs
- Waiting times
- Not knowing who the customer is or their requirements
- Paper vice electronic means of transferring information
- The administrative process itself—unnecessary movement of product or information

AWO is systematic and results oriented. It begins with identifying the targets of opportunity—the processes that contain non-value-added work—and narrowing the focus down to a manageable level. This allows you to get results—"real-time." Once customer and mission requirements are confirmed document the actual work.

Next, tear into the work content, identifying value-added and non-value-added work along with queue and wait time. Finally, systematically eliminate the non-value-added work and queue time through a reiterative effort of brainstorming and trying of new ideas.

Benchmarking

Another process available for continuous improvement is benchmarking. Benchmarking is an organized way for Air Force units to become more innovative—an essential ingredient to infuse excellence in all we do.

The defense of our country requires the aggressive pursuit of *best-in-class* service in all operational and support areas. Process improvement must be accelerated wherever necessary to assure operational efficiency and effectiveness at the benchmark level.

Executive Order 12862, Setting Customer Standards, directs benchmarking "customer service performance against the best in business." "Best in Business" shall mean the highest quality of service delivered to customers by private organizations providing a comparable analogous service.

Benchmarking directly impacts the QAF Criteria, the framework for improving overall unit performance. Benchmarking is addressed throughout the criteria as an essential component to develop appropriate goals and attaining superior processes and, most importantly, results.

Definition

David T. Kearns, former CEO of Xerox, provided one of the earliest definitions of benchmarking .".. the continuous process of measuring products, services, and practices against the toughest competitors or those companies recognized as industry leaders."

From this early definition of benchmarking evolved many other definitions to include the Air Force definition … the process of finding and adapting best practices to improve organizational performance.

Benchmarking is a process and not just a tool. It requires inputs that are systematically addressed through valued-added activity to reach an end product (superior performance). Benchmarking is about finding, which reflects the discovery piece of learning. Adapting, not adopting, suggest our willingness to take what we learn from others, combine those learnings with our own organization's wisdom, and exhibit our action-oriented bias for process improvement. A single or absolute best practice may be elusive; however, we must find what are recognized as best practices to achieve breakthrough levels of performance. All this is done to improve organizational performance (results).

Characteristics

Unlike other improvement methods such as CIP, reengineering, problem solving, etc., benchmarking requires developing an *external* orientation to the unit's performance in relation to others. Further, benchmarking does not merely encourage organizations to compare themselves with others, but to learn from them. The benchmarking process finds the best practices and explains "*how*" and "*why*" their performance is the standard of excellence.

Benchmarking is not just a "study." When leadership commits itself to achieving *benchmark* levels of performance, it should implement improvements based on the findings of the benchmarking team. Without implementation, have only conducted a comparative study—not a complete benchmarking effort.

Reasons for Benchmarking

A typical scenario might be as follows: A process action team learns that another organization was "world-class" and probably had a best practice worth considering. The team decides the process is critical to the entire organization. Senior leadership approves a change for the team to benchmark against the best in class, and the team finds quantum improvements not thought possible until seeing success from the other organization.

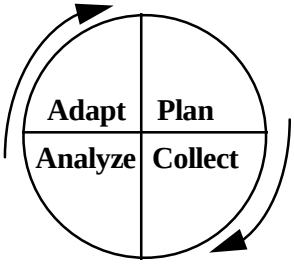
Important reasons to benchmark include:

- Attaining higher mission effectiveness ratings
- Improving the quality of services and products (doing it better); shortening cycle times (doing it faster); and reducing operations and support costs (doing it cheaper)
- Establishing actionable and rational goals for strategic planning
- Addressing "opportunities for improvement" from the unit's self assessment

The benchmarking process promotes *breakthrough* improvements enabling an organization to match or even surpass other organizations with similar processes. Why does it work? Benchmarking is directly tied to the unit's mission and goals —It's the essential methodology for "best-in-class" or "world-class" performance!

Methodology

The benchmarking process involves four phases: planning the benchmarking effort, collecting information, analyzing the data and adapting best practices. An adaptation of the Shewhart Cycle.



Planning Phase¾ What should be benchmarked? What can be gained from the benchmarking effort? These two questions will help focus activities during the initial planning phase.

Seek the leadership support of an executive champion from the onset. This person may be a process owner, squadron commander, member of the wing quality council or someone capable of implementing the findings and recommendations of the team.

Assemble a team composed of at least one or two members directly involved in the targeted process area. Contact the local quality improvement office or command *benchmarking champion* to obtain training.

Benchmark a key process (or sub-process) that will directly impact one of the key result areas—look to the organization's strategic plan to identify priorities for benchmarking. Don't benchmark an unmanageable process like aircraft maintenance—it's just too big. Look at subprocesses that are manageable and still directly impact the organization's goals. If you select a process at too low a level, e.g., at the task level, the benchmarking efforts will be *suboptimized*. Anticipate the benchmarking candidate process to be cross-functional and impact more than one office or section across the organization.

Once a process is selected to benchmark, study it in depth. There might be discrepancies that easily can be addressed through optimizing on-hand resources called *entitlements*. If found, make corrections where appropriate, baseline performance, then press on with benchmarking. Since a benchmarking partnership is benefited by mutual disclosure, document the process and be willing to share it with a benchmarking partner. Do not attempt to collect data before finishing planning the study.

Collecting Phase¾ Start this phase by reviewing the internationally recognized *Benchmarking Code of Conduct* (Appendix E) to guide all data collection efforts. In this phase, try to identify the criteria in a benchmarking partner to assure a meaningful exchange of information. Those individuals closest to the process (customers, suppliers or workers) may be able to help identify a handful of potential benchmarking partners. As necessary, consider the limited use of screening surveys, detailed questionnaires or interview questionnaires.

Take a disciplined approach to collecting data in the following order:

- *Internal research.* Look inside your organization for previously conducted research.
- *External research.* Look outside your organization to other armed services or public domain sources.
- *Primary investigation.* A trip is not always necessary, but if it is, review and strictly adhere to the benchmarking code of conduct.

Analysis Phase¾ The volume of data collected may be overwhelming. Examine the performance data to find out how well their processes perform, and more importantly, look for the process data to tell you why their process is superior. The best practices may jump out at you immediately!

Analysis is necessary to compare their data (collection phase) against your data (planning phase). In the event you end up with apples-to-oranges, *normalize* the data to make relevant comparisons and analyze the performance and/or process gaps.

Once you've made the comparison, study the best practices and their associated enablers—the things, processes or cultural elements that make their practice superior. The best practice may not be singular nor cosmic, but if it contributes to the benchmark-level performance, consider how to use it in the organization.

"The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them."

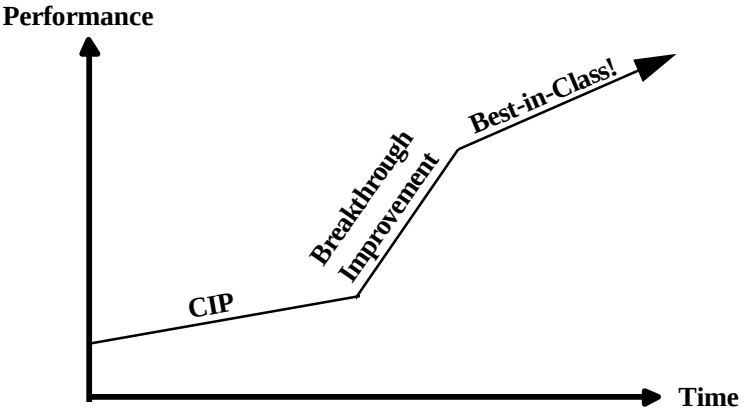
Sir William Bragg

Adaptation Phase¾ Communicate the team's findings to those responsible for implementing the best practices as well as the stakeholders involved. If necessary, senior leadership may wish to adjust organizational goals based on this new information. Develop an action plan to implement the best practices in a way that works with the organization's culture. Depending on the process level targeted, look for dramatic improvements to make the organization the new standard of excellence.

A word of caution: benchmarks are not static. Recalibrate the benchmark as required to maintain organizational effectiveness. Ensure superior performance longevity by re-benchmarking the process—benchmarking cycle time should be shorter the second time around.

Benchmarking and Continuous Improvement

Once the best practices are implemented and performance has stabilized, the seven-step continuous improvement process (CIP) takes over. The CIP is essential to raising the organization's standard of excellence even higher and not being complacent with "best-in-class" performance.



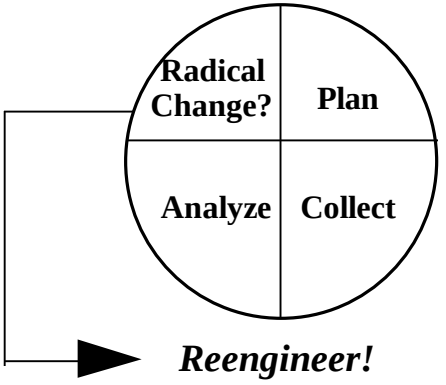
Use the CIP in conjunction with benchmarking to make incremental improvements until the benchmark must be recalibrated. Until that time, benchmark another key process while CIP is running on the first process benchmarked.

Process Reengineering

Having just completed the benchmarking study, the benchmarking team may conclude that the best practice(s) can not be easily adapted without overhauling important functions of the organization. The team may recommend to senior leadership that the process be dramatically changed through reengineering —the process of radically redesigning a process to achieve a breakthrough in performance. To reengineer a process, senior

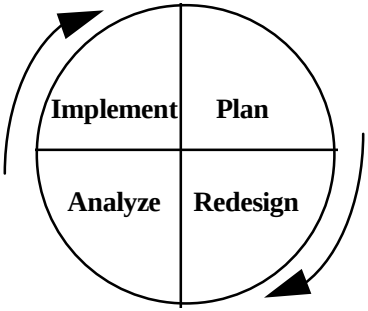
leadership may also need to consider the redesign of the organizational structure, its management system and possibly its values to attain and surpass benchmark performance levels.

Caution: Reengineering is usually considered a "clean sheet" approach to implementing organizational change. The results will be dramatic—positively or negatively— depending on the organization's approach. For this reason, it's important to benchmark *before* reengineering to develop a sense of what success looks like before dramatically altering the manner in which the organization operates. From the benchmarking model, the "jumping off point" for reengineering would be prior to the *adaptation phase*:



Reengineering Methodology

Reengineering may involve many steps and sub-steps depending on the level of complexity of the reengineering effort. The phases of this methodology, like benchmarking, can also be linked to the Shewhart Cycle of Plan-Do-Study-Act through the phases of planning, redesigning, analyzing and implementation.



Planning Phase¾ Attaining senior leadership commitment is more critical in beginning a reengineering effort than a benchmarking effort since the reengineering effort is a more radical approach to breakthrough improvement.

Planning for reengineering involves many of the same components as the planning phase of benchmarking. As in benchmarking, first learn what the organization does before asking why it is done. Review the efforts of previous process analysis in benchmarking planning. Although not exclusively reserved for reengineering, reengineers commonly use more sophisticated analytical tools to diagnose the current process.

Redesigning Phase¾ Knowing "how" the work is performed, the team must now ask "why" the work is performed. Question everything. Throughout this phase, the team will be generating alternative approaches to process redesign. In doing so, the team will determine its criteria for a reengineered process. Consider both efficiency measures (costs and cycle times) and effectiveness measures in describing an ideal reengineered process. The team may use idea generating tools to create alternatives such as simple brainstorming techniques.

Most importantly, consider applying new or emerging technologies to your process. For example, information technology is a key *enable* to maintaining competitiveness in most operational and support areas.

Analysis Phase—This phase is actually comprised of two parts: selecting between alternatives and identifying the impact of the new design on the organization. Selection between the various options will be based on potential benefits of each alternative. The team may develop scenarios or "to be" state descriptions for each alternative. A performance comparison may still be checked against the benchmark.

Project the impact of the redesign on the organization's personnel, physical and monetary resources, culture, and other processes and strategic priorities. Try modeling the future state and developing scenarios to predict the impact of the change to the mission and the organization.

Implementation Phase—Success of any reengineering effort is dependent on the ability to properly implement the new design. Communicate the findings to the stakeholders as the earliest opportunity.

Again like benchmarking, this phase involves project management. However, unlike benchmarking, ownership of previous organizational functions may change. Managing dramatic change will involve careful project planning to assure the organization continues to perform its mission in the midst of turmoil that radical change brings.

Reengineering and Continuous Improvement

Reengineering is *not* a frequently used organizational process improvement tool nor should it be. It should be reserved for cross-functional processes that impact the organizational performance and can not be corrected by creatively adapting best practices. Once a redesigned process is implemented and performance has stabilized, hand the process over to the continuous improvement process for "adjustments" as necessary.

Once we reengineer the process, when do we reengineer it again? It may be necessary to reengineer again if the "rules of engagement" change for the process. These rules may change based on trends in technology, competition or strategic imperatives. The reengineering model depicts a wheel that turns and repeats its cycle, but unlike the frequently turning Deming Wheel, the reengineering wheel should turn only when necessary then stop. With today's demanding pace and requirements for organizational flexibility, the wheel should always be an available option to maintain competitiveness.

6

Quality Air Force Assessments

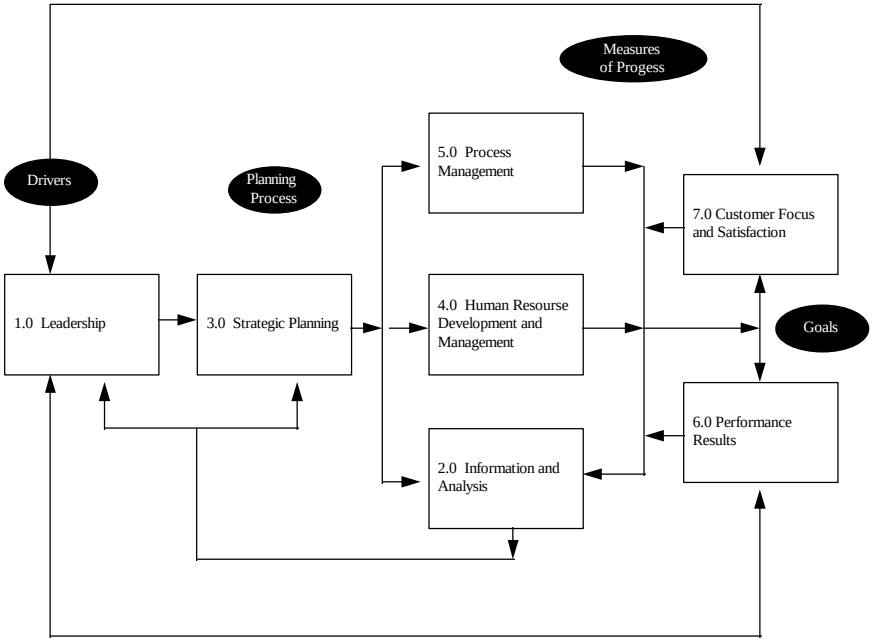
In the past, military inspections focused on individual components of an organization looking for conformance to a predetermined standard. However, Quality Air Force assessments focus on the entire system's level of performance. Both a Quality Air Force Assessment (QAFA) and Unit Self Assessment (USA) allow units to evaluate their success in applying the principles of Quality Air Force. The QAFA—an external assessment—and the USA—an internal assessment—identify organizational strengths and opportunities for improvement. They help focus improvement efforts on areas having the most impact on the unit's ability to meet mission requirements. Assessments ultimately provide leaders a "nonprescriptive" feedback report describing the organization and its current performance levels. These assessments are based on the Quality Air Force Criteria.

Quality Air Force Criteria

The QAF Criteria, based on the Malcolm Baldrige National Quality Award (MBNQA), are grouped into seven broad categories. The categories provide the framework to "tie together" the multitude of seemingly independent tasks units perform to accomplish the mission and assess their relative effectiveness. The four elements of the QAF Criteria framework are as follows:

- **Driver¾** Senior leadership is responsible for: setting the direction for the organization; creating organizational values, goals and systems; and guiding the pursuit of customer value, mission accomplishment; performance improvement and customer satisfaction
- **Planning Process¾** Well-defined and well-planned processes are essential to meeting the organization's mission and customer performance requirements
- **Measures of Progress**—These measures serve as a results-oriented basis for channeling actions to improve organizational mission performance
- **Goals¾** Goals deliver ever-improving mission performance and value to customers

Criteria Systems Model



This Criteria Systems Model, derived from Figure 1.1 in AFI 90-501, depicts the connection and integration of the categories that comprise the whole system. The driver of the system is leadership. The organization's senior leaders focus efforts on meeting current and future mission and customer requirements. Inputs to the planning process come from data on the current and future mission and customer requirements, as well as organizational performance measures. The measures of progress include: data from the customer's perspective; operational performance measures; human resource and development measures; and financial performance measures. All of these inputs are tracked in the information and analysis function. The goals of the system are to continuously improve the organization's operational performance, mission accomplishment and customer satisfaction.

The QAF Criteria offer a well-designed framework to help raise performance standards and expectations and help in planning, training and assessment. The following are specific ways applying the criteria can benefit an organization:

- Help best execute the mission by becoming more effective, efficient and focused
- Emphasize how different units act in concert to produce a unit's end product mission
- Facilitate communications based upon a shared knowledge of quality and mission requirements
- Improve overall operational performance within the organization
- Enable a thorough, accurate assessment of an organization's systems and how they affect customer and supplier relationships and mission accomplishment

The QAF Criteria are arranged into seven categories. Here is a brief summary of each.

1.0 Leadership

Senior leaders demonstrate their commitment to quality principles through personal involvement in directing the organization's focus. They also prove their commitment by being directly involved in quality efforts and receiving education and training in the quality disciplines. You can measure top leadership involvement by observing several things. How is Quality Air Force integrated throughout the organization? Are the senior leaders driving and supporting the implementation? Are daily operations oriented and focused toward the customer and mission? Has this focus extended throughout the base community? Exploring these questions will indicate your senior leaders' level of commitment.

2.0 Information and Analysis

The drive for quality excellence demands a strong push to effectively manage and use data and information. This category examines the scope, validity and analysis of data used to improve operational performance. It helps a unit determine if it is collecting and managing the information important to operational and mission performance improvements. How do the data and information systems your unit employs support improvement efforts toward customer and mission focus? Do they provide information on the unit's internal operations? Is the right information readily available to the people who need it to drive improvement efforts? These questions help assess the organization's ability to improve operational performance.

3.0 Strategic Planning

Plans should include performance improvement goals and quantifiable objectives—both short and long term—for all key areas in an organization. Does the organization's planning process consider: future customer and mission requirements, human resource and development requirements, expected developments in technology and changes in its environment, budget and manning? What long and short-term plans are produced by this process? How does the organization translate and deploy the key quality and performance requirements to the entire organization? Answering these questions will assist in the strategic planning process.

4.0 Human Resource Development and Management

People are the Air Force's most important resource; this category examines the way an organization manages and develops its people. Does the organization help workers reach their full potential? Are people enabled and empowered to reach quality and operational performance goals? Do they receive the support and training needed to help the organization reach the goals and objectives in its strategic plan? Does the organization's environment satisfy the needs of its internal customers? These questions can lead to a better understanding of an organization's approach and deployment of methods to improve the development of its work force.

5.0 Process Management

Key processes help consistently deliver high levels of operational performance. This category examines how a unit translates its customer and mission requirements into processes capable of meeting those requirements. It takes a look at how an organization manages, controls and improves these processes to ensure they continually meet customer and mission requirements. Finally it examines how the organization assesses and improves the

quality of the products and services it receives from its suppliers. Systematic quality improvement and quality and performance assessment are major players in this category.

6.0 Performance Results

Every organization needs proof or evidence that the processes and programs it implemented actually improved quality and overall mission performance. How do you get this evidence? Measure the inputs, process and outputs of the operations. Data collected from these measures cover the entire system, from the supplier of parts and services, through the daily operations, to the end result—mission readiness.

7.0 Customer Focus and Satisfaction

Successful organizations consistently meet or exceed customers' needs and mission requirements. This category addresses the interface between each organization and those outside organizations (or individuals) who receive the key products and services. The unit's mission statement helps identify the organization's customers. The entire cycle of external customer contact is contained in this single category—from determination of basic needs through post-delivery feedback. Organizations that deliver high quality mission performance, that listen to customer feedback and adjust to meet changing requirements, hold the key to continually excelling in their mission.

Scoring the criteria

These 7 categories are divided into 24 items. The system used to score an organization is based on the unit's response for the criteria's 24 items. Use the score to baseline the organization. The scoring system has three dimensions: approach, deployment and results. "Approach" refers to the systematic method(s) used to achieve the requirements addressed by the items —the "how" an organization accomplishes the item. "Deployment" is the method and extent the approach is applied. "Results" refers to outcome and effect in achieving the purposes addressed in the criteria.

QAF System Model and QAF Criteria Interrelationship

The QAF system model is guided by leadership which is the "driver" for the QAF criteria. The seven QAF categories are an interwoven system used to diagnose the effectiveness of a unit in accomplishing its mission and service to its customers. The inputs to the system are customers and their requirements. A unit first needs to define its customers and then identify what is important to each one (7.0). Once customer requirements are identified, the leadership (1.0) can develop its mission and direction. Once the mission and direction are defined, the organization can identify measures of success within the Information and Analysis category (2.0). In the quality focus area, senior leaders develop short- and long-term goals and strategies relating to each of the performance measures during the strategic planning process (3.0). Based on the goals and improvement strategies outlined in the organization's plans, the following systems and processes should be developed: human resource systems (4.0); work processes in the direct and indirect areas of the organization (5.0); and processes used to manage relationships with customers (7.2). Quality in daily operations ensures these systems and processes are implemented, measured and reviewed regularly. All of these systems and processes must work together to produce internal performance

results (6.0) and external results for customers (7.4 and 7.5). Depending on the results improvement processes can be used to ensure the products and services meet mission requirements.

Quality Air Force

The language of Quality is heard at all levels of the Air Force. There are many different methods for implementation. This handbook is just one reference to use to sustain the quality journey towards process improvement and mission enhancement. These concepts, models and measurement tools have proven to be of value in the pursuit of improving operations and quality of life.

"As we look to the future, a quality culture will continue to be important to our Air Force. We will employ its tools and its techniques. We will help our service become leaner, more flexible, more agile. We will operate in a decentralized manner to keep up with the pace of events. People at all levels will have to know their business. You'll have to be ready to seize the initiative to exploit opportunities as they arise. And you'll need to be bold, to think outside the box, to seek out fresh and innovative ways to capture the promise of air and space."

General Ronald R. Fogleman
USAF Chief of Staff

JOHN W. HANDY, Major General, USAF
Director,Programs and Evaluation

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Process Improvement Guide

Tools for Generating Ideas

Brainstorming, asking "Why?", and mental imaging are all tools to help generate ideas. These tools work well for individuals or groups. Flexibility is critical. Be ready to change techniques to suit the group's mood and purpose. Here's a quick look at tools for generating ideas:

- Brainstorming
  - ✓ Generates multiple ideas about a problem or topic
  - ✓ Works well in groups of all sizes
- Five "Whys"
  - ✓ Discovers the root cause of a problem
  - ✓ Shows how causes of a problem might be related
- Mental Imaging
  - ✓ Helps visualize key relationships and obstacles
  - ✓ Creates a detailed picture of an ideal situation

Brainstorming

This tool, which doesn't involve analysis, builds a "shopping list" of ideas about a specific problem or topic in a short time. Here's what to do:

Write the problem or topic on a blackboard or flipchart where everyone can see it. Include all ideas; don't edit the remarks. Try to withhold judgment until the session is complete. Don't forget to give your group quiet time to generate ideas, and be sure to involve process owners, customers and suppliers. Each of the following techniques can be used by itself or in combination to suit the team. If there are too many ideas after brainstorming, trim the list with a decision-making tool.

Structured brainstorming gives everyone an equal chance to participate. Solicit one idea at a time from each person. Participants may "Pass" if they have no comment. Continue until everyone "passes." Although, structured brainstorming is rigid and lacks spontaneity, this eliminates the influences of rank or strong personalities.

Use free-form brainstorming when you want a less structured approach to brainstorming. Be aware that less assertive or junior-ranking members may feel intimidated or "outgunned" by using this method, and they may not contribute. Work in a relaxed environment, and encourage everyone to contribute ideas as they come to mind. This gives participants the opportunity to build on each other's ideas.

Switch to silent brainstorming if team members can't resist analyzing the contributions. Ask each participant to write ideas on sticky-back notes or small slips of paper. Then collect the papers and post them for all to see. Silent brainstorming may lose the synergy that comes from an open session, so it may be more effective when it's used in combination with other brainstorming techniques.

What works best? It depends on the topic, team members and their mood. One approach may be to combine these two methods. For example, start the session with a few rounds of structured brainstorming and finish up with a period of unstructured brainstorming.

Five "Whys"

The Basics: Ask "Why?". That's the key to finding the root cause (or causes) of a problem. This technique can also help spur understanding of how different causes might be related. Another advantage of using this technique is focusing on the process instead of personalities. Here's what to do:

The Process: Describe the problem in specific terms. Everyone should have a chance to contribute opinions. Be specific in the choice of words to help keep everyone focused.

Ask "Why?" Why did the problem occur? The question might have to be asked more than once. Just keep asking "Why?" until the root causes have been identified. (You've identified the root cause when asking "Why?" doesn't yield any more useful information.)

An Example: Office workers wanted to discover why they missed their Initial Operating Capability (IOC) date. So they asked "Why?" and here's what they learned:

We missed the IOC.

Why?

Our contract delivery date slipped.

Why?

There were numerous engineering changes.

Why?

The contractor didn't understand our initial requirements.

Why?

We took only one week to prepare it.

Group members discovered that poor requirements planning was a root cause of their problem. To improve their process, they decided to budget "up-front" time in the planning process for requirement analysis.

Mental Imaging

The Basics: To achieve goals, visualize achieving them. Mental imaging helps describe a desired outcome and the conditions needed to make it happen. Professional athletes often use mental imaging to reach their goals. Use this process to visualize key relationships and obstacles within a situation. Warm up by visualizing something pleasant—your favorite vacation spot, perhaps. Empty your mind of negative thoughts before you start. Here's what to do:

The Process: *Relax¾* Take five or six deep breaths. Block out the pressures of work and home.

Imagine¾ What would happen if ideal conditions existed? How would that affect the outcome of your processes? Jot down your ideas. If you're part of a group, use the individual ideas to create a combined description of the ideal process.

Assess the current conditions¾ Are they different from the ideal conditions you've imagined?

Define the gaps¾ What's different between the current and ideal conditions?

Identify obstacles¾ What stands between the current state and the ideal state you imagined?

An Example: The commander asked the audiovisual manager to create a slide presentation to "enhance the image of the organization." The slides would be used at the annual Quality Air Force Symposium.

Before starting, the graphics manager visualized a peaceful landscape scene. She imagined standing in a sunny meadow, surrounded by flowers; she saw snow-capped mountains in the distance. Next, the manager envisioned an "ideal" environment. She visualized many excellent slides and widespread support for the project. The ideal environment would have a profound impact on the outcome—the result would be the best presentation seen at the symposium.

Then the manager thought about the everyday work environment, and realized it was different from the imagined "ideal" state. There were less than a hundred slides in the collection, and many were out-of-date. Several branch managers refused to allow photographers inside their workcenters. The staff photographer was on vacation, and the organization's best camera was being repaired.

Despite these obstacles, the manager kept the "ideal" in mind and went to work. She knew the presentation would be successful, and she was determined to make it happen.

Tools for Decision Making

Decision-making tools help keep the process moving once ideas have been generated. Multivoting, nominal group technique, pair-wise ranking and force field analysis are tools that can help. Here's a quick look at these tools:

- Multivoting
  - ✓ Finds the important items on a list
  - ✓ Avoids a "win-lose" situation for group members
- Nominal Group Technique
  - ✓ Prioritizes items in a list
  - ✓ Makes decisions based on inputs from all

- Pairwise Ranking
  - ✓ Prioritizes items in a short list
  - ✓ Reaches decisions by consensus
- Force Field Analysis
  - ✓ Identifies the significant forces of the process
  - ✓ Helps identify improvement opportunities

Effective Decision-Making

Meet in a suitable place. Schedule the decision-making meeting in a room quiet and free from interruptions (telephones, co-workers, etc.). Have plenty of flipcharts, markers and other supplies.

Combine items where possible. Look at the list. One method might be to place each idea on a post-it-note then put them on a flipchart or board so everyone can touch and move them around. Are any items similar? Give group members a minute or two to review the items. Then ask them for their opinions. Work as a group to combine similar ideas where it is feasible.

Number each item on the list. This makes it easy for group members to refer to item, and saves time as well.

Base decisions on data. Try to keep intuitive decisions to a minimum. Data-driven decisions can speed your process.

Understand the politics of decision-making. When people make decisions as a group, the decision-making process usually fits one of seven styles ranging from no decision to consensus.

The following is a guide to consequences when groups make decisions. The types of decision-making are listed with the percentage of group involvement and a profile of the decision style.

Ø **No decision**— 0 percent—issue avoided. All members do not want to discuss the issue.

- **Decision by powerful minority** — 20 percent involvement—decision made by powerful minority or individual. Other opinions not invited.
- **Bartering** — 40 percent involvement—competing powerful individuals or cliques make "trade-offs."
- **Consultative decision** — 50 percent involvement—decision made by powerful individuals about the "expert" opinion.
- **Majority vote** — 60 percent involvement—minimal discussion of minority point of view. Minority concedes.
- **Majority rule** — 80 percent involvement—decision by majority vote, but minority viewpoints explored as well.
- **Consensus¾** 100 percent involvement—needs and interests of all explored and a unified team solution develops into an action plan.

Multivoting

The Basics: Prioritize the items on a list by multivoting. This simple, fast technique works best for large groups and long lists. The benefit to prioritize the list without creating a "win-lose" situation for group members. This tool also helps you separate the "vital few" from the "trivial many" on a large list. Here's what to do:

The Process: *Empower*. First, count the number of items in the list. Divide that number in half; that's the number of votes each team member receives. For example, there would be ten votes for a 20-item list.

Vote. Each member votes for the items they believe have high priority. Then compile the votes.

Select the top items. Identify the top four, five or six items. If there is still a problem identifying the top few, then drop the items with the fewest votes and re-vote. Once the top items have been identified discuss and prioritize these items.

An Example: Members of a system program office (SPO) often participated in meetings held across the nation. Unfortunately, the meetings were often unproductive. The division chiefs, hoping to improve this situation, scheduled a brainstorming session. Here's the list they generated:

1. No agenda
2. No clear objectives
3. Going off on tangents
4. Extraneous topics
5. Unproductive
6. Time spent on travel
7. Money spent on travel
8. Too much "dog and pony"
9. Problems not mentioned
10. Unclear charts
11. Few meaningful metrics
12. Trouble calling home office
13. No parking
14. No administrative support

Since there were 14 items, each team member had seven votes they could use to reduce the list to a manageable size. Here's how they voted:

| | 1. No agenda
|||| 2. No clear objectives
|| 3. Going off on tangents
| 4. Extraneous topics
|| 5. Unproductive
|||| 6. Time spent on travel
|||| 7. Money spent on travel
|||| 8. Too much "dog and pony"
|| 9. Problems not mentioned
|||| 10. Unclear charts
|||||| 11. Few meaningful metrics
12. Trouble calling home office
13. No parking
14. No administrative support

As a result of the vote, the group chose to focus on problems 2, 6, 7, 8, 10 and 11.

Nominal Group technique

The Basics: The nominal group technique (NGT) is a structured method to generate and prioritize a list. This method uses priorities of each group member to discover the overall group priorities. Here's what to do:

The Process: *Generate and prioritize ideas.* Use silent brainstorming to generate ideas. Then clarify and consolidate those ideas.

Use letters. First, assign a letter to each idea. For example, assign the letters "A" through "H" if there are you had eight ideas. Next, have each person write the assigned letters on a piece of paper.

Prioritize the lists. Ask each person to prioritize their list by writing a number beside each letter. If there are eight ideas, then identify the most important idea with the number "8." Work through the list, identifying the least important idea with the number "1." Remind group members they may use each number just once.

Compute the total for each letter. What's the highest score? That letter has the highest priority; the letter with the lowest score has the lowest priority.

An Example: Here's a list of office problems identified during a brainstorming session:

A. Ineffective organizational structure

B. Poor communications outside the office

C. Lack of training

D. Poor communications within the office

E. Unclear mission and objectives

F. Poor distribution of office mail

G. Lack of feedback on management reports

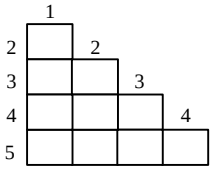
Each group member then wrote the letters "A" through "G" on a piece of paper, and prioritized each of the seven items ("7" was the highest; "1" was the lowest). Take a look at the results:

Problem	Person 1	2	3	4	5	Total	Priority	
A	6	5	7	5	6	29	#2	
B	3	2	4	1	3	13	#5	
C	1	1	2	2	2	8	#7	Lowest priority
D	4	4	5	6	4	23	#4	
E	7	7	6	7	5	32	#1	Highest priority
F	2	3	1	3	1	10	#6	
G	5	6	3	4	7	25	#3	

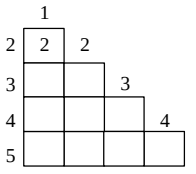
Pairwise Ranking

The Basics: If there is a small list of items, try pairwise ranking. This structured method ranks a small list of items in priority order. It can help make decisions in a way that's consensus-oriented. Here's what to do:

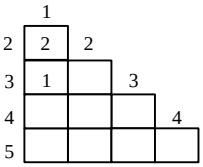
The Process: *Construct a pairwise matrix.* Each box in the matrix represents the intersection (or pairing) of two items. Let's say the list has five items. A pairwise matrix would look like this (the top box represents idea "1" paired with idea "2"):



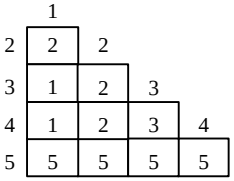
Rank each pair. Using a consensus-oriented discussion for each pair, have the group determine which idea they prefer. Then, for each pair, write the number of the preferred idea in the appropriate box. Keep doing this until you've filled the matrix.



1 and 2 compared;
2 is better...



1 and 3 compared;
1 is better...



4 and 5 compared;
5 is better.

Count the number of times each alternative appears in the matrix.

Alternative	1	2	3	4	5
Count	2	3	1	0	4
Rank					

Alternative "5" appears four times in the matrix

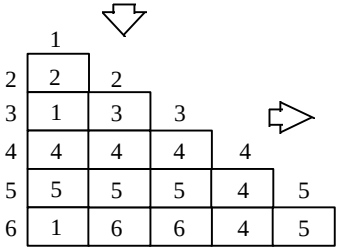
Rank all items. Rank the alternatives by the total number of times they appear. Do two ideas appear an equal number of times? Break the tie; look at the box in which those two ideas are compared.

Alternative	1	2	3	4	5
Count	2	3	1	0	4
Rank	3rd	2nd	4th	5th	1st

Alternative "5" ranks first overall

An Example: A feasibility study produced a list of six possible locations for testing a unique portion of a system. A program team then used pairwise ranking. The results proved that Nellis AFB was best suited for this particular test.

1. Fort Huachuca
2. Edwards AFB
3. Kirtland AFB
4. Nellis AFB
5. Eglin AFB
6. Hanscom AFB



Site	1	2	3	4	5	6
Count	2	1	1	5	4	2
Rank	3rd	6th	5th	1st	2nd	4th

Force Field Analysis

The Basics: To visualize issues or concepts that influencing the problem or goal, consider force field analysis. This technique identifies and visualizes the relationships of significant influencing forces. It identifies key factors or forces that promote or hinder your efforts to solve a problem or reach a goal. Improvement opportunities can be identified. Here's what to do:

The Process: *Define the objective* First, decide what needs to be analyzed. Is the problem or goal clearly identified?

List the forces. What key factors promote or hinder the ability to reach the goal or solve the problem? Use two lists: one for forces that promote the efforts, another for forces that hinder.

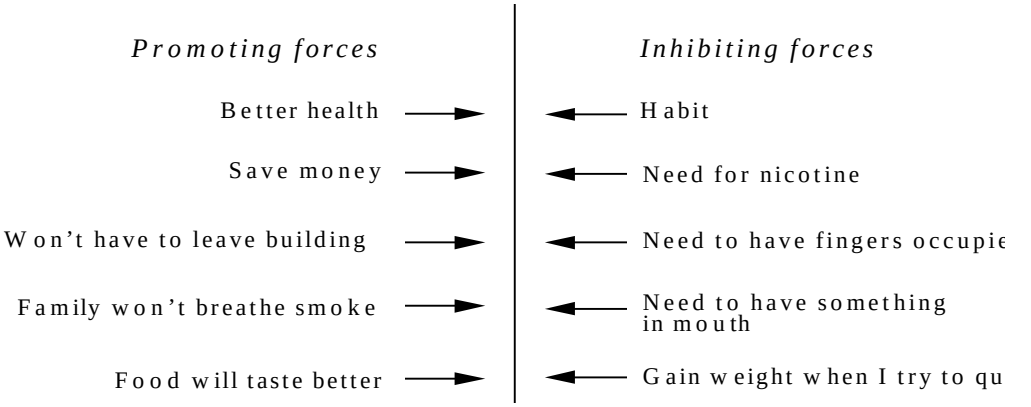
Prioritize. Consider the items listed. What is the relative impact of each item on the problem or goal? Prioritize the forces based on the impact of each item. The nominal group technique works well here or another decision-making tool could be used.

Implement. Now, strengthen or maximize the forces that promote the efforts. Then work to weaken or minimize the hindering forces.

An Example: An Air Force sergeant smoked more than a pack of cigarettes every day. His family and colleagues (all non-smokers) wanted him to quit. Despite frequent attempts to stop, the

sergeant continued to smoke. One day he sat down with the quality advisor, and did a force field analysis. Here's what he found:

Goal: Quit Smoking



After completing the force field analysis, the quality advisor worked with the sergeant to prioritize the forces. That helped the sergeant decide which forces to strengthen and which to weaken.

Tools for Process Analysis

Flowcharts, affinity diagrams and cause-and-effect diagrams are excellent analysis tools. You can also use thematic content analysis or a Pareto chart in your analysis efforts. Here's a quick look at tools for analyzing problems:

- Flowchart
  - ü Shows how the whole process works
  - ü Identifies critical stages of a process

- Affinity diagram
  - ü Shows relationship between factors in a problem
  - ü Identifies areas where you most need improvement
- Cause-and-effect diagram
  - ü Determines causes of a particular effect
  - ü Identifies areas where more information is needed
- Thematic content analysis
  - ü Summarizes raw data into useful categories
  - ü Shows patterns in raw data
- Pareto chart
  - ü Identifies and separates major and minor problems
  - ü Prioritizes problems

Flowchart

The Basics: Want to see what a process looks like from start to finish? A flowchart is a graphical representation of all major steps of a process. To understand the complete process, identify critical stages within a process, and locate problem areas. Flowcharts also show relationships between different steps in the process. Here's what to do:

The Process: *Identify the process.* First, define start and finish points for the process being examined.

Describe the current process. From the starting point, chart the entire process. Work slowly and include every step along the way, right through to the finish. Use standard flowchart symbols to improve the clarity of the flowchart, but they're not essential.

Chart the ideal process (this is an optional step). Try to identify the easiest and most efficient way to go from the "start" to "finish." This flowchart makes it easier to find improvements.

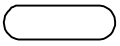
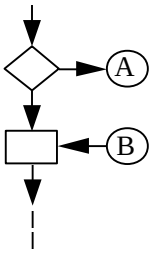
Search for improvement opportunities. Study the flowchart. The process probably has areas that hinder or add little or no value. Look at the flowchart, and examine any steps that differ from the ideal process, and question why they exist.

Update the chart. Build a new flowchart that corrects the problems identified.

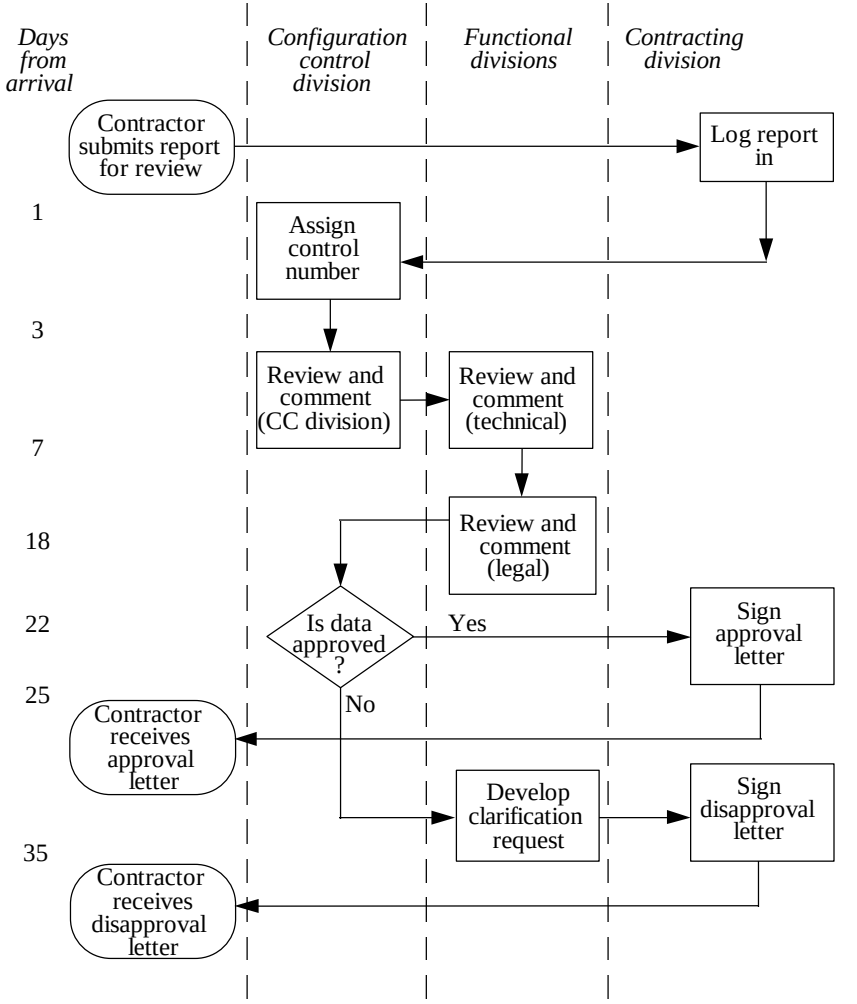
When working on the flowchart, consider using index cards or sticky-back notes to record each step of the process. Then rearrange the diagram without erasing and redrawing. This can reduce the chances of losing valuable ideas.

The following are standard flowchart symbols. When developing a flowchart, the goal is to chart the process. Don't waste time debating these symbols. The flowchart will be useful with or without these symbols.

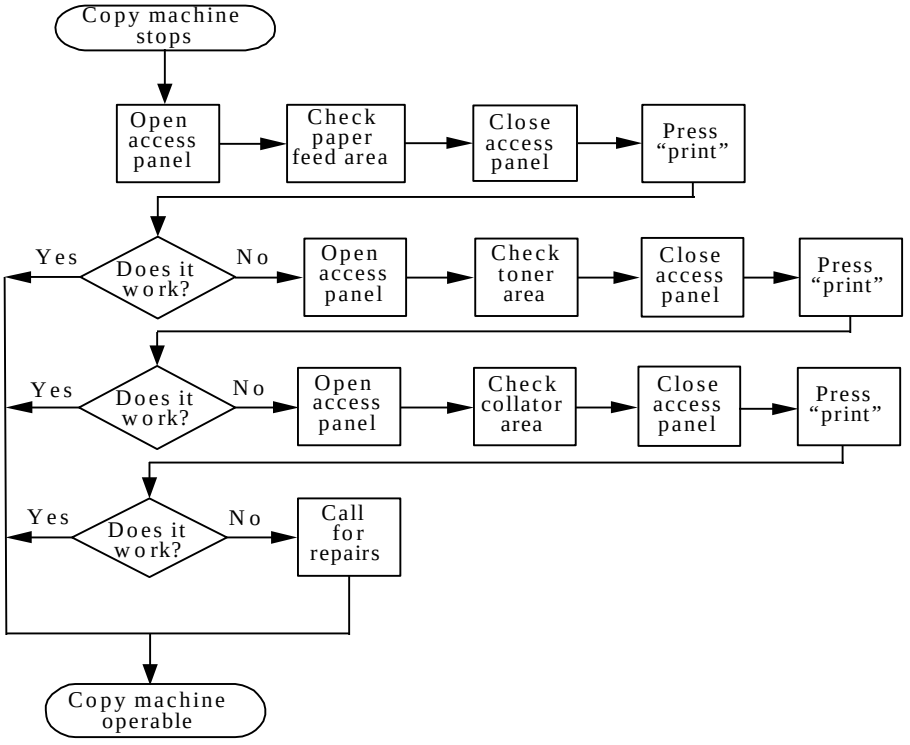
Standard flowchart symbols

Symbol	*Meaning*	*Examples*
	Start/stop	Receive trouble report Machine operable
	Decision point	Approve/disapprove Accept/decline Yes/no Pass/fail
	Activity	Drop off travel voucher Open access panel
	Document	Fill out trouble report
	Connector (to another page or part of the diagram)	

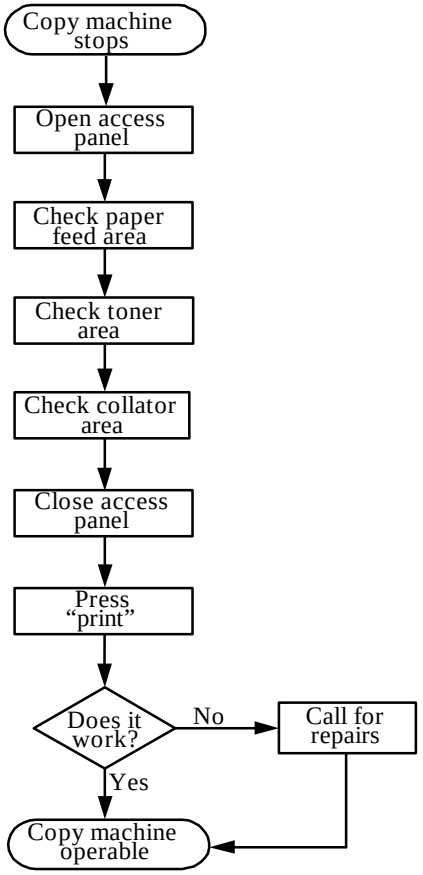
After identifying the basic flow of the process, put the flowchart on a grid. Grids categorize information about geography, organizational structure, time or other categories of information. The goal is to see the process in different and useful ways. Here's an example:



A copy machine suffered frequent paper jams, and was a notorious source of frustration. Often, a problem could be cleared by simply opening and closing the access panel. Here's a flow chart of the troubleshooting procedure most people used:



Users usually had to check several locations in the copy machine before they found the problem. An office worker posted this flowchart showing a more efficient procedure. This process reduced frustration and "panel slamming" when the machine stopped unexpectedly.



Affinity Diagram

The Basics: Exploring all aspects of an issue is easy to do when using an affinity diagram. This diagram takes verbal information, and organizes it into a visual pattern. Start with specific ideas, and work toward more broad categories. (This is the opposite of a cause-and-effect diagram, which starts with broad causes and works toward specifics.) Affinity diagrams can also help identify key areas needing improvement. First, identify the problem and generate ideas. Here's what to do:

The Process: *Cluster the ideas into related groups.* Use sticky-back notes or cards—anything easy to sort and move. Which ideas are similar? Which ideas seem connected to other ideas? Questions like these can help you group the ideas.

Create affinity cards. For each group, create a card that has a short statement describing the entire group of ideas.

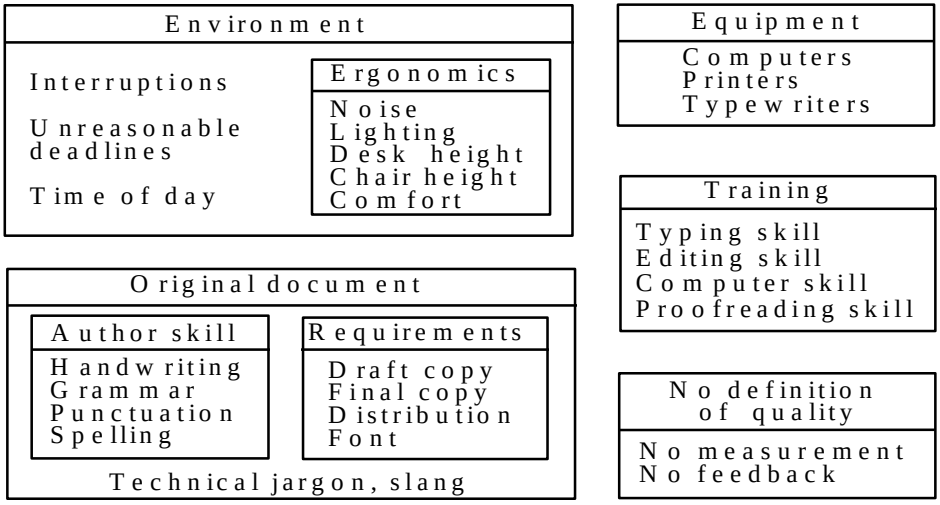
Cluster related cards. Put the group of related cards under the group's affinity card. Group the affinity cards into broader groups? Keep creating groups until the definition of "group" grows too broad to have comfortable meaning.

Create an affinity diagram. Lay out all the ideas and affinity cards on a single piece of paper; use a blackboard or table. Put the affinity cards at the top of each group, and draw an outline of the group. A hierarchical structure will develop that can offer valuable insight into the problem.

An Example: A publications team hoped to reduce typographical errors. Here's the list (generated during a brain-storming session) of factors affecting the error rate:

Computers	No feedback	Proofreading skill
Printers	Noise	Short deadlines
Lighting	Typewriters	Chair height
Comfort	Desk height	Time of day
Spelling	Interruptions	Handwriting
Grammar	Slang	Technical jargon
Draft copy	Punctuation	Distribution
Font	Final copy	Editing skill
Computer skill	Typing skill	No measurement

The team created an affinity diagram to identify areas for further analysis:

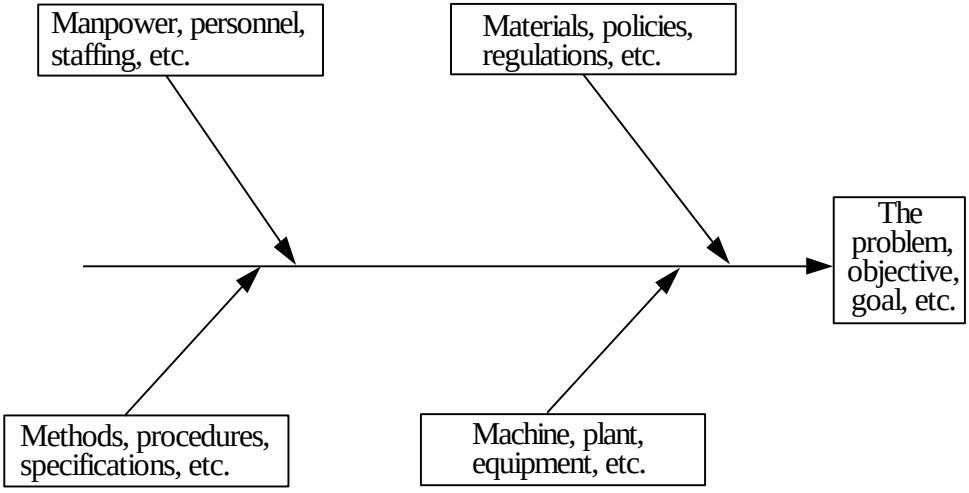


Cause and Effect Diagram

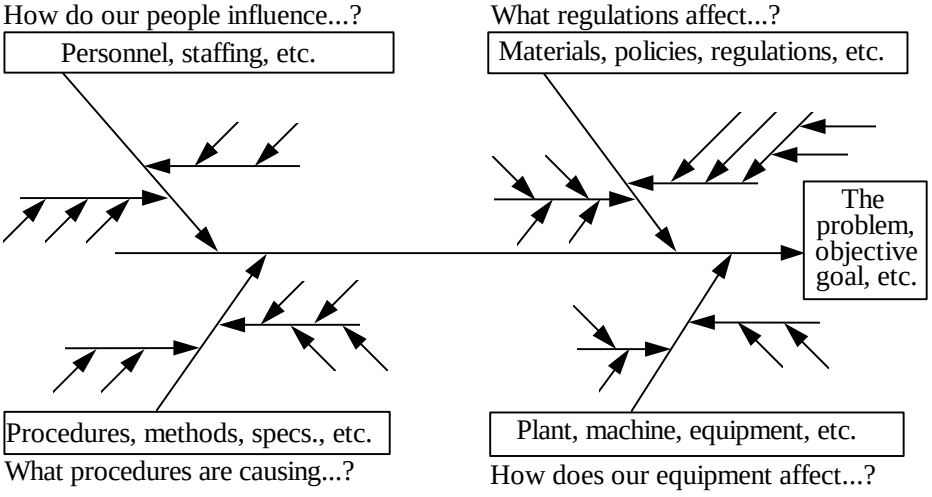
The Basics: To examine the relationship between a given outcome and the factors influencing that outcome, use a cause-and-effect diagram. Sometimes called an Ishikawa diagram or even a "fishbone diagram," the cause-and-effect diagram focuses on specific issues, identifies areas short on data and gives you a structured approach to finding root causes. Here's what to do:

The Process: *Specify the problem to analyze.* The effect can be stated positively (in terms of the objective to be accomplished) or negatively (in terms of a problem to be overcome). Place the problem's title in a box on the right side of the diagram.

List the major categories of factors influencing the effect being studied . Use the "4Ms" (methods/manpower/ materials/ machinery) or "4 Ps" (policies/procedures/people/plant) as the starting point.



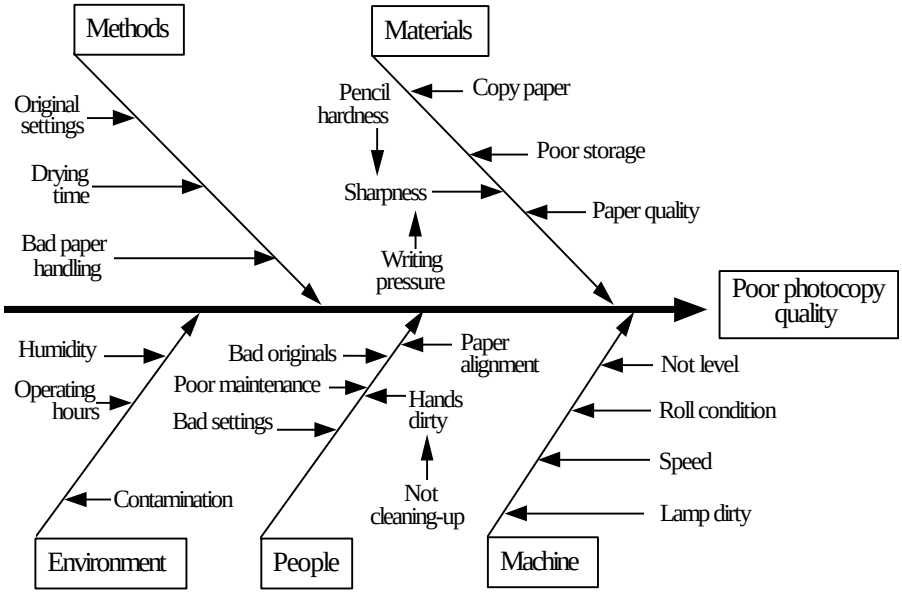
Identify factors and subfactors. Ask "Why?" or use brainstorming or mental imaging to generate ideas. Start with the major categories and work from there.



Identify significant factors. List the factors having a significant effect (data can help identify these).

Prioritize the list of causes. Don't confuse the location of ideas with importance—a subfactor may be the root cause to all the problems. After prioritizing new factors may be discovered then more data should be collected.

An Example: The frustrated office workers put their heads together and identified specific issues in their search for the root cause. Take a look:



Thematic Content Analysis

The Basics: To find patterns in raw data, use thematic content analysis. This analytical technique can help summarize and categorize data. Analyze data from surveys, questionnaires and interviews. Here's what to do:

The Process: *Obtain data.* Use the data from a questionnaire, interview or a survey.

Combine answers. Make a single list for each question and record all the answers to that question. If an answer is repeated, place a mark beside the original response.

Determine themes. What are the recurring themes of the responses? Try to match the responses to these themes. Don't forget to include a miscellaneous category for responses that don't easily fit into your major categories. Miscellaneous category gets too big, try to analyze it and find a common theme.

Incorporate the results. Use the major issues identified to help move the process forward.

An Example: When managers decided to improve their government agency's process for awarding contracts, they needed to identify the main problem areas. They involved the main customers of the contract award process—their contractors. The agency sent a questionnaire to 50 of its largest contractors. Here's what the thematic content analysis of the responses looked like:

Questionnaire

1. What do you feel is the biggest problem with our contract award process?
2. ...
3. ...

# responses	*Answers to first question*
𝍸 𝍸 𝍸	A. The whole process takes too long.
𝍸 |	B. We spend a lot of time and resources reproposing/resubmitting.
𝍸 𝍸 𝍸 |	C. We have to generate a great deal of data.
𝍸	D. There are too many specifications.
𝍸 |	E. We have to submit too much cost data.
||	F. We have to document everything.
|||	G. It's impossible to keep up with all the latest regulations/standards.

Themes

Too many data requirements: C, E, F

Too long and costly: A, B

Too complicated: D, G

Pareto Chart

The Basics: Pareto charts are bar charts based on the Pareto Principle: 20 percent of the problems have 80 percent of the impact. Those 20 percent are the "vital few." Separating the problems or issues in this way helps you focus on the improvement process. Why? A Pareto chart allows you to arrange data according to priority or importance. This takes the guesswork out of the process. Here's what to do:

The Process: *Identify the possible problems.* Use brain-storming, mental imaging or ask "Why?" to generate ideas. List all the possible problems in a particular process.

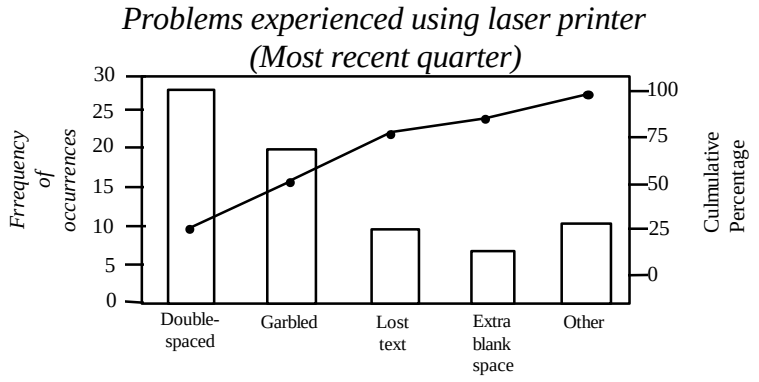
Use existing reports or collect new data on the process. Group existing data by consistent units of measure. That means dollars, percentages, pounds, etc.

Label the chart. Put frequency of occurrence on the left vertical axis and categories of problems on the horizontal axis.

Plot the data. Order the categories according to their frequency (how many), not their classification (what kind). Use a descending order from left to right. If there are stray categories, include an "other" category.

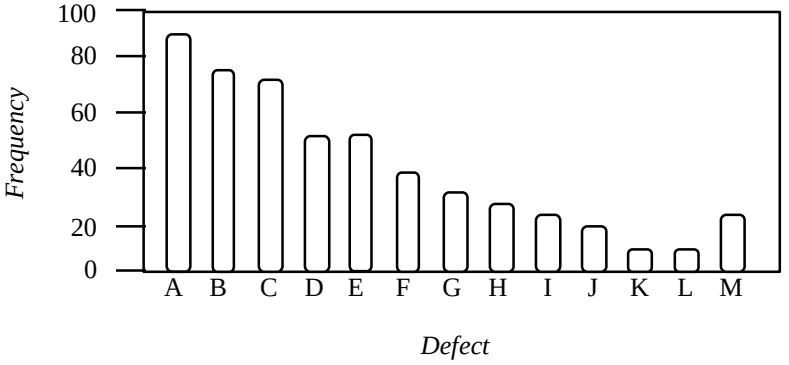
Here's an optional step: use the right vertical axis to measure the cumulative percentage of total occurrences summed over all the categories.

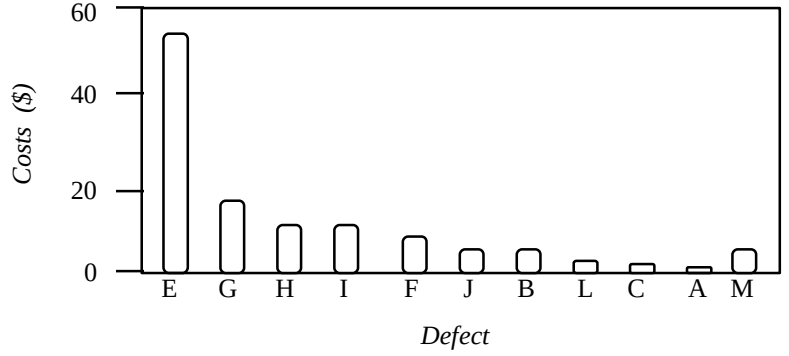
An Example: The office staff experienced a lot of trouble with a new laser printer. This Pareto chart helped them identify the "vital few" problems. The left side shows the frequency of occurrences; the actual problems are listed along the bottom:



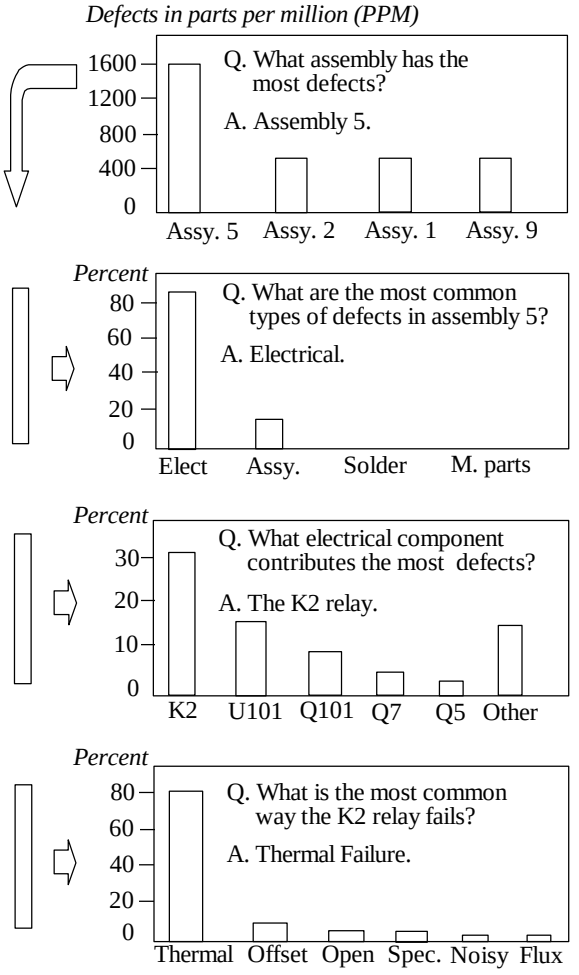
Next is a comparison of frequency and cost. The most common defect is "A." The most costly defect, though, is "E."

Take a look:

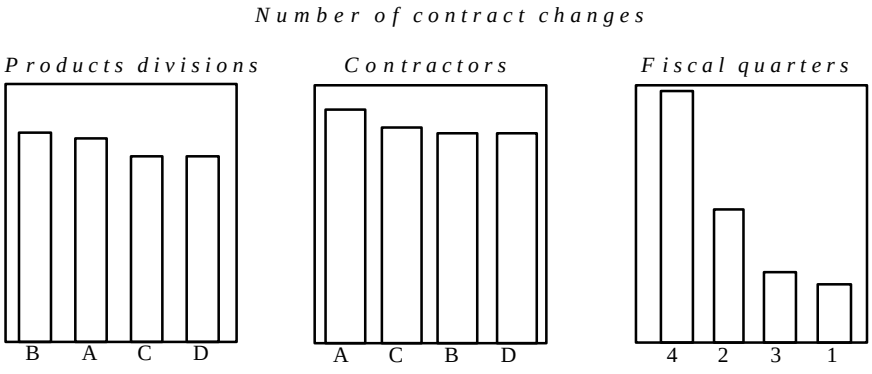




An Example: If there are broad causes, break them down into specific areas to help improvement efforts. These specific areas are within the broad causes—that's why the term "nested Pareto charts" is used. Here's a look at the concept:



An Example: Here's an example of a stratified Pareto chart. The same data can be plotted against different potential causes to determine the significant problem. This concept is useful when original A Pareto chart doesn't clearly identify one or two significant problem areas. Be imaginative and be creative when defining the problem categories.



Using this analysis, there doesn't appear to be much difference in contract changes among different product divisions or among different contractors. There does appear to be a large difference across fiscal quarters.

Tools for Analysis of Process Data

The following is a list of tools that are used for the analysis of process data:

- Checksheet
  - ü Helps collect data easily
  - ü Converts raw data to useful information

- Histogram
  - ü Displays the underlying distribution of process
  - ü Illustrates the total variability of the process
- Scatter diagram
  - ü Shows relationship between variables
  - ü Identifies possible causes of problems
- Run chart
  - ü Shows changes in a process over time
  - ü Helps recognize abnormal behavior in a process
- Boxplot
  - ü Shows center point and variation of a set of scores
  - ü Can be displayed repeatedly to show trend
- Control chart
  - ü Gives detailed look at trends and variation
  - ü Shows changes in a process over time
  - ü Includes process driven control limits
- Process capability ratio
  - ü Links control charts to customer requirements
  - ü Relates process variability to tolerance requirements

Checksheet

The Basics: An organized method of collecting data is a checksheet. This simple form helps convert the raw data into readily useful information. An excellent advantage to checksheets is that they help translate opinion into fact. Here's what to do:

The Process: *Clearly identify what's being observed.* Make sure everyone collecting data is looking for the same thing. Be specific about the event or activity observed.

Keep the data collection process as easy as possible. Don't make data collection a job in itself. Using simple check marks to fill in the checksheet is easy.

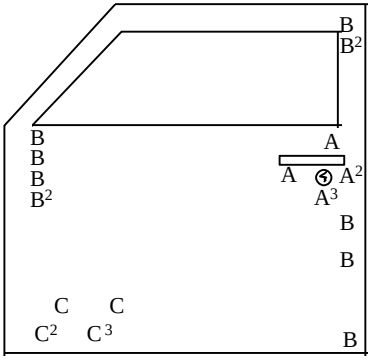
Be creative. Develop a checksheet format that will give you the most information with the least amount of effort.

Reasons for misplaced letters

Defect	May 6	May 7	May 8	Total defects
Wrong mailbox	|||	||||	||||	11
Wrong city	||	𝍸	𝍸 |	13
Wrong zip code	𝍸 ||||	𝍸 ||	𝍸	21
Old office symbol	|||	|	|||	7
Total defects	17	17	18	52

Pictorial checksheets can give much more information than tabular checksheets. Take a look:

Finish defects on 100 drivers' doors (after 25,000 miles)



Defect	Tally	Total
Scratch	𝍸 ||	7
Chipped paint	𝍸 |||	11
Tar	𝍸 ||	7
Dent		0
Total defects		25

A - Scratch
B - Chipped paint
C - Tar
D - Dent

Note: A^3 = 3 scratches in close proximity, etc...

An Example: During testing, an electronic system control console experienced an unusually high failure rate in some of its black boxes. To help analyze the failures, the program office managers developed a pictorial checksheet. Here's what the checksheet looked like after 120 days of testing:

Days	Upper TypeA	Upper TypeB	Upper TypeC	Ctr TypeA	Ctr TypeB	Ctr TypeC	Low TypeA	Low TypeB	Low TypeC
1-30					3	3 3 3			
31-60	3			3		3 3 3 3		3 3	
61-90		3		3	3 3	3 3 3 3			
91-120			3		3	3 3 3 3 3 3 3			3
Fails	1	1	1	2	4	18		2	1

Most failures (18 of 24) occurred in boxes along the center of the equipment racks, and most of these failures were type "C" (shutdown during test). A facility inspection revealed a heating duct ran directly behind these boxes. The resulting high temperatures caused the equipment to overheat and fail.

Histogram

The Basics: To show the central tendency and variability of a data set use a graph called a histogram—sometimes referred to as a frequency distribution. A histogram can help you determine the underlying distribution of a process. Histograms also help understand the total variability of a process. When using histograms, each data point appears in only one interval. The number of intervals can influence the pattern the data will take. Don't expect histograms to be a perfect bell curve; expect variations. Here's what to do:

The Process: *Determine the type of data to collect.* Make sure the data are measurable. Times, lengths and speeds are examples of measurable data.

*Collect the data***.** Obtain a random sample of data from the process. Collect as many measurable points as possible. Then count the total number of points collected.

*Determine the number of intervals required***.** Use this guide to determine how many intervals (or bars) the graph should have:

If you have these many data points:	*Use this number of intervals:*
< 50	5-7
51-99	6-10
100-249	7-12
>250	10-20

Determine the range. Study the data set. Subtract the smallest value from the largest. This value is the range of the data set.

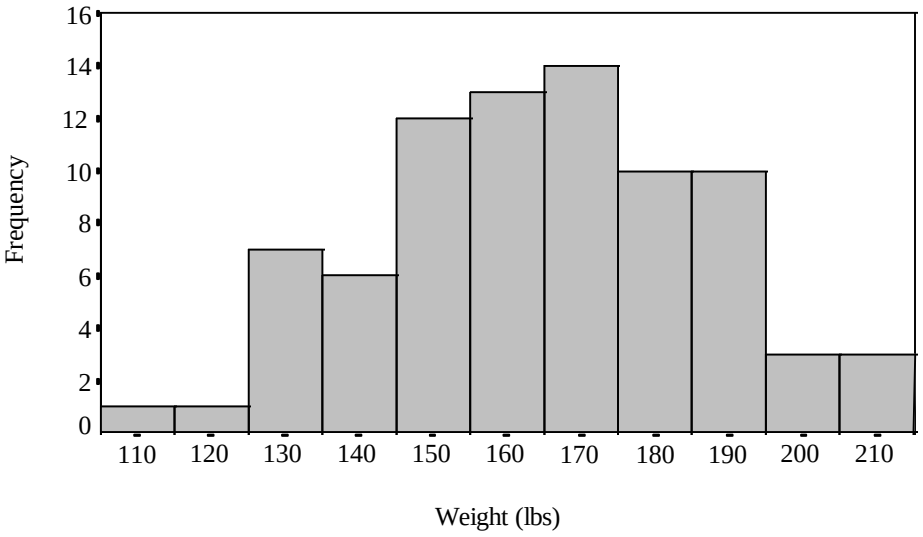
Determine the interval width. Divide the range by the number of intervals. Round answers up to a convenient value. For example, if the range of the data is 17 and nine intervals are used, then interval width is 1.88. Round this interval to 2.0. It's a good idea to carry the intervals to one decimal place more than the data collected.

Determine the starting point of each interval. Use the smallest data point value as the starting point of the first interval. The starting point for the second interval is the sum of the smallest data

point plus the interval width. For example, if the smallest data point is 10 and the interval width is two, then the starting point for the second interval is 12. Label intervals along the horizontal axis.

*Plot the data***.** Count the number of data points that fall within each interval; plot this frequency on the histogram. Remember: each data point can appear in just one interval. For example, if the first interval begins with 10.0 and the second with 12.0, then all data points that are *equal to or greater than 10.0 and still less than 12.0* are counted in the first interval.

An Example: During aerobic testing, evaluators weighed 80 Air Force officers. Here's a histogram and a table showing the distribution of the data. Which format is most useful?



Weights of 80 officers

208	180	139	163	159
155	180	165	149	127
159	171	141	190	159
153	181	180	137	161
115	156	173	165	191
159	109	179	145	144
150	206	166	188	165
127	130	172	180	147
145	150	156	171	189
190	200	208	169	139
130	128	155	185	166
165	187	159	178	169
147	150	201	128	170
189	163	150	158	180
139	149	185	129	169
175	189	150	201	175

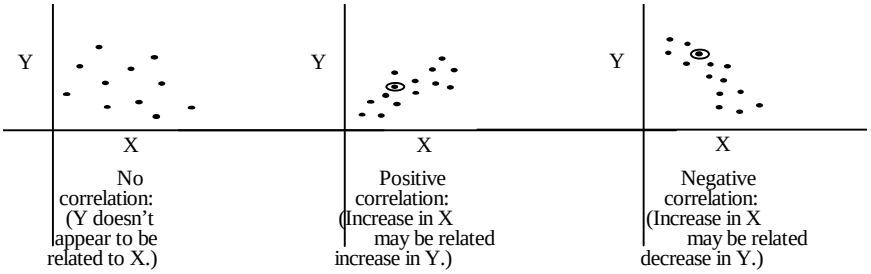
Scatter Diagram

The Basics: Recognize the relationship between two variables with a scatter diagram. These diagrams are graphs that reveal possible relationships and also help identify possible causes of problems. An important note: while this method shows a relationship exists, it won't show that one variable causes another. Further analysis using other statistical techniques will quantify the strength of a relationship between two variables. Remember, that when a relationship exists between two variables, they're correlated. (Both positive and negative correlations can be useful for continuous process improvement.) Here's what to do:

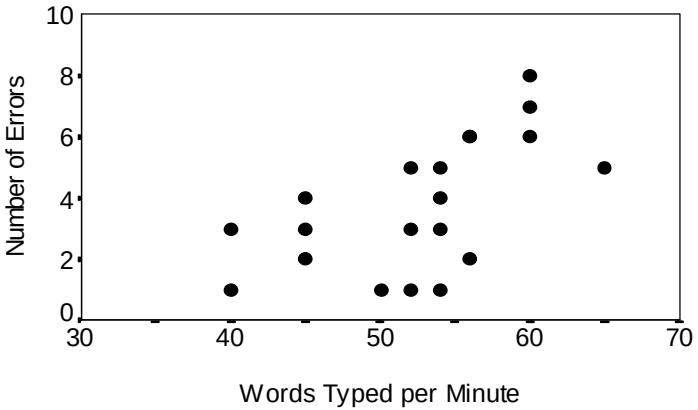
The Process: *Collect the data in pairs.* Find two different variables (X and Y) that appear to have a relationship. Each point on the scatter diagram is an (X,Y) pair of values. There will be many (X,Y) datapoints on one scatter diagram.

Construct the graph. Label the horizontal and vertical axes in ascending order. Make sure the value on the two axes correspond to the data pairs.

*Plot the data***.** Look for patterns when plotting each point, circling repeated points. Here's an illustration to help you interpret scatter diagrams:



An Example: A typing agency wanted to investigate the relationship of speed of typing and errors made.



Observations about the Scatter Diagram

One person typed 65 words per minute with five mistakes. One person typed 40 words per minute with three mistakes. There are differing errors rates for the same words per minute typed. As the words per minute increased the number of errors increased.

Run Chart

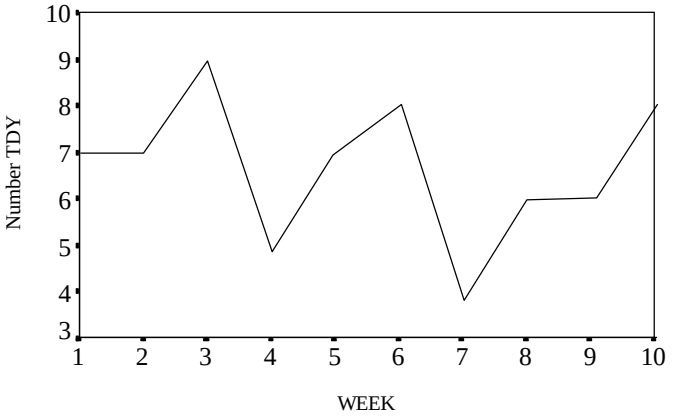
The Basics: To show changes in a process measurement over time, use a run chart. A run chart may also help recognize abnormal behavior in a process. Here's what to do:

The Process: *Construct the chart.* Label the vertical axis with the key measurement of the process you want to measure. Label the horizontal axis with units of time.

Plot the data. After collecting the data, plot each data point on the chart.

Interpret the chart. One signal that shows the process has significantly changed: six steadily increasing or decreasing points in a row. Another possible signal: nine points in a row that are on the same side of the average.

An Example: Here's an example of a run chart tracking the number of people who travel each week. It's important to recognize the variability inherent in any process. In this process, the variability is the number of people traveling (four to nine people). Take a look:



Boxplot

The Basics: A boxplot, sometimes called a box and whisker plot, is a graph that offers a detailed picture of the center point and variability of a distribution of data. Boxplots can also help identify the changes in a process measured over a period of time or show differences in similar processes (instructor ratings for different instructors covering the same material). Here's what to do.

The Process: *Understand the terms.* 100 percent of the data points fall below the highest data point. 75 percent of the data points fall below the upper quartile, with 25 percent above it. The number data points are divided equally at the median—50 percent below and 50 percent above it. At the lower quartile, 25 percent of the data points below, with 75 percent of the data points above it. And finally, 100 percent of the data points are above the lowest data point.

Collect the data. Collect the data by subset— weeks, days, questions, etc.

Put the data in sequential order. For each subset, put the data in a row or column. Start with the lowest data point and end with the highest. For example, this subset has nine data points:

2, 4, 6, 6, 7, 7, 7, 8, 10

Determine the median. The median is the mid-point of the sequentially ordered data set. In other words, it's the point where half the data points are above and half are below.

If there are an odd number of data points the median is the middle data point and the same number of data points are on either side of the median. For example, the underlined "7" is the median for this dataset with nine datapoints:

2, 4, 6, 6, <u>7</u>, 7, 7, 8, 10

Does the subset have an even number of data points? Then the median is the average of the two middle data points. For example with 10 datapoints in which the median is the average of 6 and 7:

1, 2, 4, 6, **6,** **7,** 7, 7, 8, 10

Determine the quartiles. Quartiles are the points at which there is 25% of the data. If there are an odd number of data points in a subset, the median is in both the upper and lower quartiles. Here's an example—the median and the upper and lower quartiles are underlined:

2, 4, **6,** 6, **7,** 7, **7,** 8, 10

If there are an even number of data points in a subset the quartiles are the midpoints of the upper and lower halves. Here's an example—the quartiles are underlined, and the letter "M" represents the median ("M" is 6.5, which is not a datapoint and is acceptable):

1, 2, **4,** 6, 6, **M,** 7, 7, **7,** 8, 10

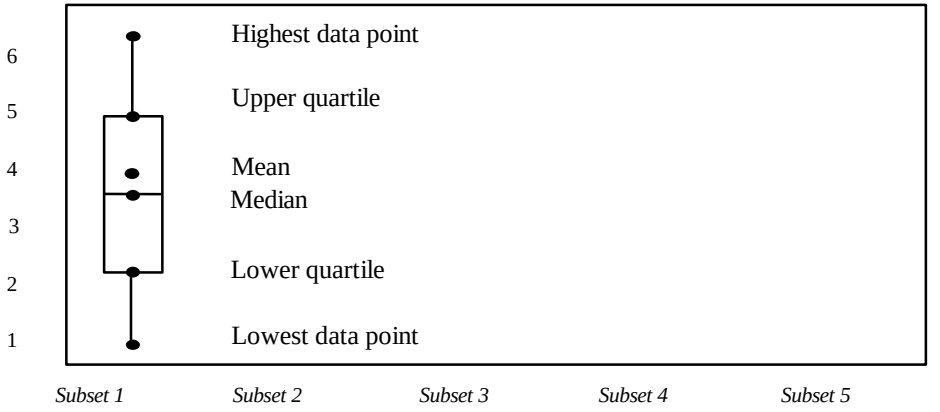
Determine the mean. To obtain the mean (X), or average, add all numbers in the subset and divide that sum by the number of data points in the subset. For example, here's the mean for the nine data points in this subset:

2, 4, 6, 6, 7, 7, 7, 8, 10

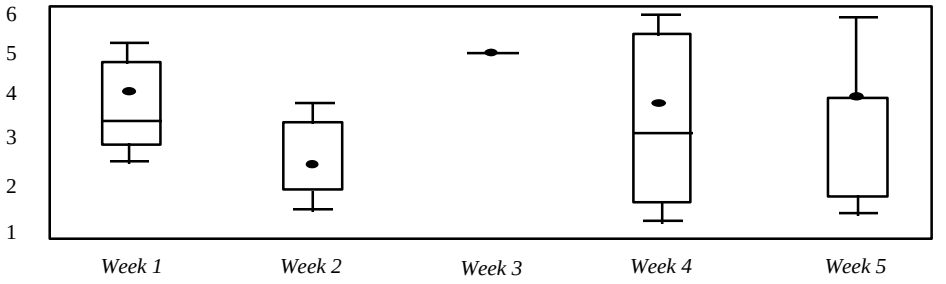
$2 + 4 + 6 + 6 + 7 + 7 + 7 + 8 + 10 = 57$

$\overline{X} = 57$ (sum of the scores) $\div$ 9 (number of scores) = 6.33

Plot the data. Draw the axes for the entire data set. For the first subset, put a dot at the highest data point, the lowest data point, the quartiles and the median. Draw a box in the space between the two quartiles. Then draw a line at the median. Draw lines from the quartiles to the highest and lowest data points. Finally, draw a dot at the mean. Here's an example:



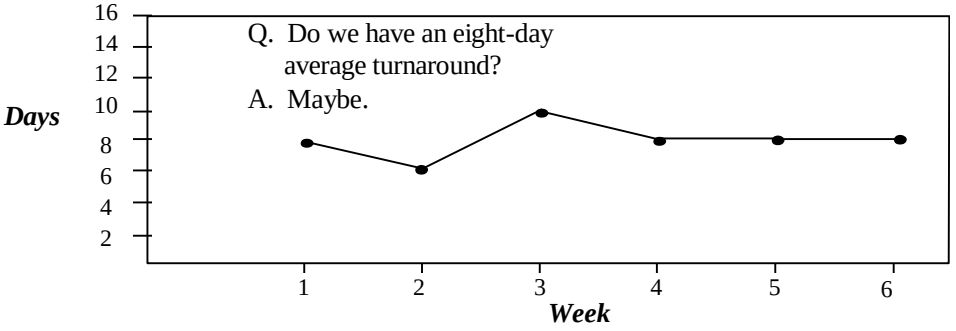
Boxplots can be repeated over time or for different groupings. Just draw a box and whisker plot for the other subsets of data:



Interpret the data. These boxplots show two center points (median — and mean **I**) and the amount of score variation for each week. It identifies whether the process is changing over time or if the spread of scores is changing over time.

Run charts vs. boxplots

The traditional approach puts attention on average performance:



The process-focused approach puts attention on satisfying the majority (75%) of customers:

An Example

An Air Force office wanted to become more customer-focused. Take a look at the customer survey conducted:

Question	*Strongly disagree*					*Strongly agree*
1. Employees in this organization are courteous.	1	2	3	4	5	6
2. Work is completed in a timely fashion.	1	2	3	4	5	6
3. Work is completed correctly the first time.	1	2	3	4	5	6
4. I am satisfied with the overall performance of this organization.	1	2	3	4	5	6

The office received 22 responses during one week:

Q	*Responses*																					
1.	6	6	6	5	6	6	6	6	5	6	5	6	6	5	6	6	6	5	6	5	6	6
2.	4	3	4	4	4	3	4	5	6	5	4	3	4	3	5	6	6	5	4	5	5	4
3.	5	6	5	4	3	4	5	5	5	4	4	4	3	2	3	3	3	6	4	4	4	3
4.	5	6	5	5	6	6	5	5	5	4	3	5	6	5	5	5	5	4	4	5	5	5

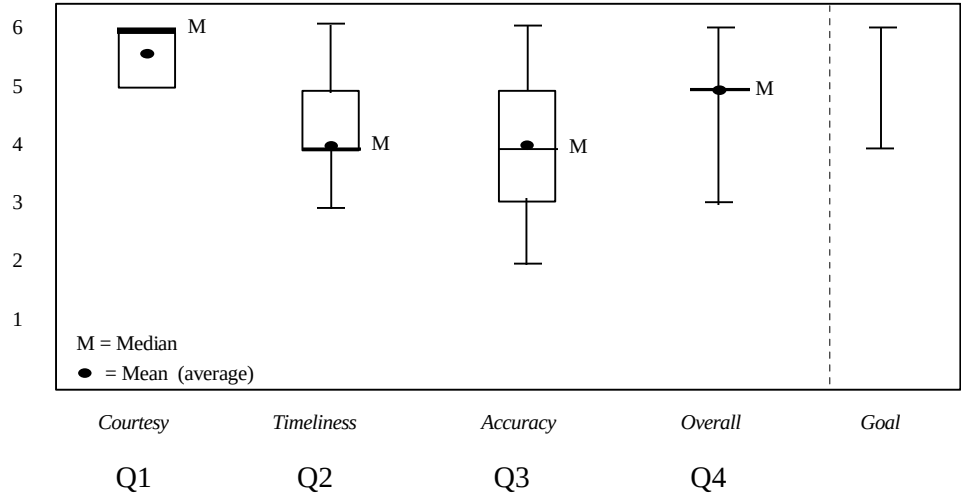
The office placed each question's responses in numerical order. The "M" represents the median; the underlined numbers represent the quartiles:

1.	5	5	5	5	5	**5**	6	6	6	6	6	**M**	6	6	6	6	6	**6**	6	6	6	6	6
2.	3	3	3	3	4	**4**	4	4	4	4	4	**M**	4	4	5	5	5	**5**	5	5	6	6	6
3.	2	3	3	3	3	**3**	3	4	4	4	4	**M**	4	4	4	4	5	**5**	5	5	5	6	6
4.	3	4	4	4	5	**5**	5	5	5	5	5	**M**	5	5	5	5	5	**5**	5	6	6	6	6

Here's a summary of the data used in making the boxplot:

Q	*Lowest data point*	*Lower quartile*	*Median*	*Mean (average)*	*Upper quartile*	*Highest data point*
1.	5	5	6 + 6 / 2 = 6	5.8	6	6
2.	3	4	4 + 4 / 2 = 4	4.4	5	6
3.	2	3	4 + 4 / 2 = 4	4.4	5	6
4.	3	5	5 + 5 / 2 = 5	5.0	5	6

Here's the data plotted:



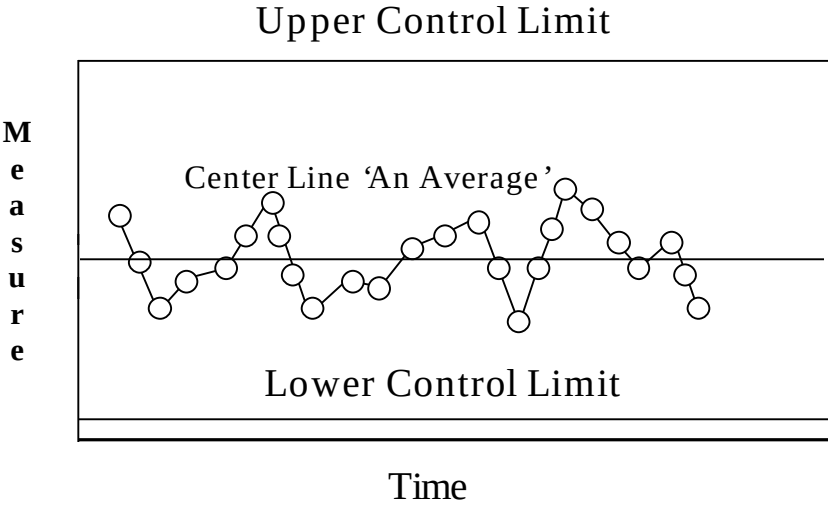
The survey revealed members of the organization were very courteous to their customers. The survey also showed these people needed to improve the accuracy of their work as well as their ability to meet schedules. The organization's goal is to have all customers satisfied—defined as a rating of four or higher.

Control Chart

The Basics: Control charts show how a process varies over time so variability can be recognized, understood and controlled. They also help identify *special causes* of variation and changes in performance. Control charts can also help avoid fixing a process which is not "broken."

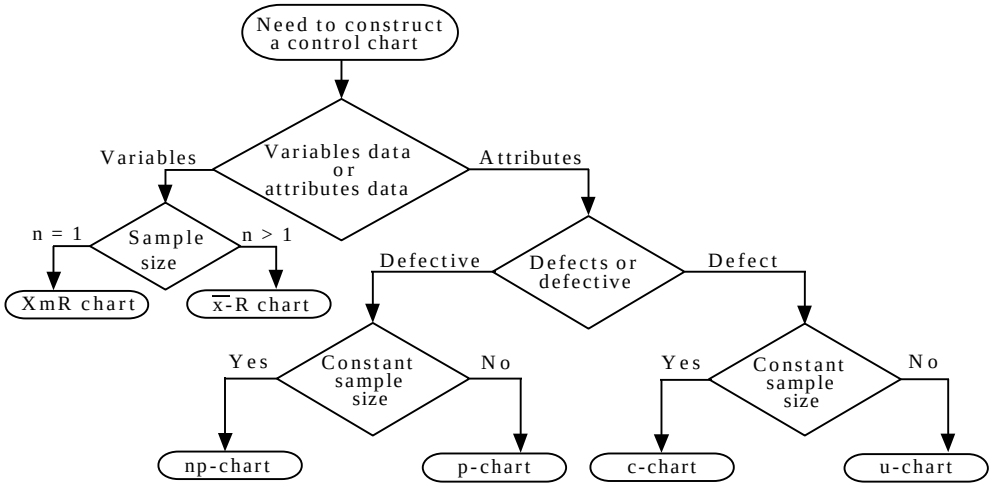
Control charts are similar to run charts, but control charts have statistically calculated upper and lower control limits. A process is in *statistical control* when the process measurements vary randomly within the control limits. That means the variation is consistent and

predictable over time. Don't confuse upper and lower control limits with tolerance limits. Control limits are computed from process information data. Tolerances are specified in standards, drawings and specifications. The relationship between process variation and tolerances is given by *process capability ratios*—more about that later. Here is a sample control chart:



The Process: *Decide what type of control chart is needed.* Control charts use one of two types of data: variable data and attribute data. To use variable data, take measurements in units such as: lengths, temperatures, etc. To use attributes data, gather "counted " data such as the number of good/bad, number of defects, or percent late. Attributes data usually are easier to collect and are less expensive to gather than variable data.

Still not sure what kind of control chart to use? Take a look at this:



Defect = A failure to meet one part of an acceptance criteria.
Defective = A unit that fails to meet acceptance criteria due to one or more defects.

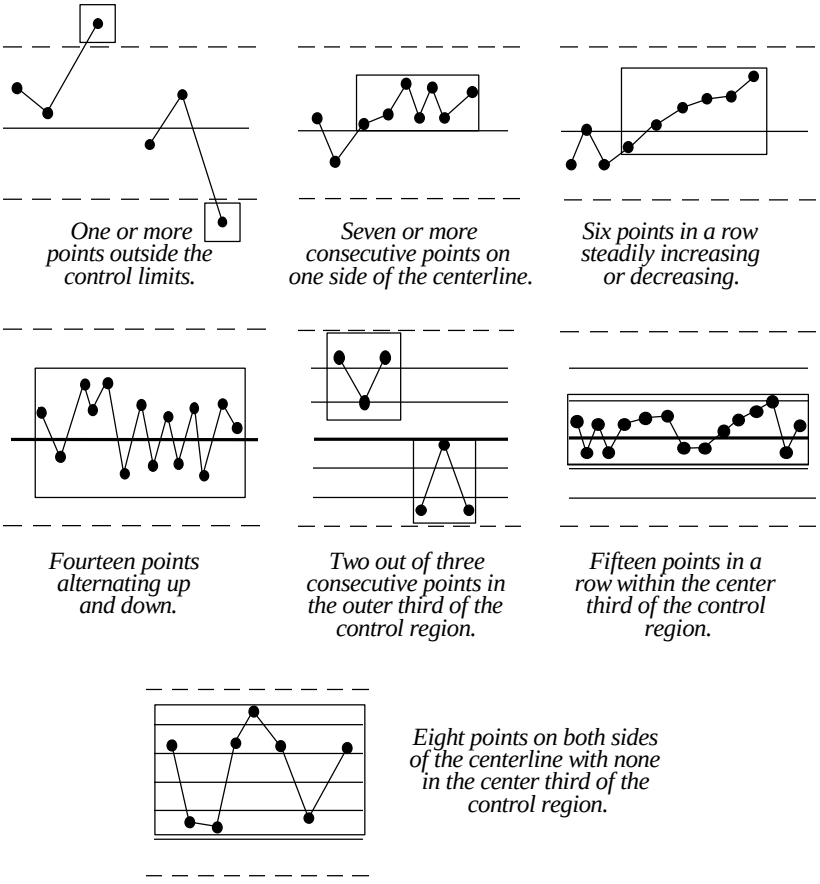
Construct the control charts. After deciding the type of data to collect, create the chart. There are several types of control charts. Here's a summary of the different charts that can be used and some strengths and weaknesses of each.

Control Chart

Type	Strengths	Concerns
	varible data	
XmR X-	Simple to construct and desirable if other factors limit the sample size.	Increased Type I and Type II error if used for attribute data.
$\overline{X}$-R	Good for preventing nonconformances and truly controlling a process.	Difficult and costly Costly
	counted data	
c and u	Good for troubleshooting because specific defects are tracked. Data is relatively easy to obtain.	Little value from a prevention perspective.
p and np	Good management overview tool.	Little value from a troubleshooting or prevention view.

Identify and eliminate any special or assignable causes of variation. To determine if these causes exist, look for one or more of the seven "signals" described on the next page. There's a low probability that any of these "signals" will occur at random—that's why they're a signal that something has changed in the process. If possible, eliminate those causes.

Control Chart 'Signals'



Reduce overall variability. Eliminate all special causes, and try to reduce the remaining variability in the process.

XmR Charts

An XmR chart is actually a pair of charts: one X chart and one mR chart. The X chart is a plot of some measured process characteristic that can change over time. The mR chart is a plot of

the moving range of X. (The moving range is the difference between a specified X value and the one preceding it.) After plotting the X and mR data points on the XmR charts, complete the appropriate control limits.

For the X chart, the center line (CL_X) represents the average process value and $m\overline{R}$ represents the average of the moving range values. How to calculate follows.

X chart

Upper Control Limit(X) $UCL_X = \overline{X} + 3/d_2(m\overline{R})$

Center Line $= \overline{X}$

Lower Control Limit(X) $LCL_X = \overline{X} - 3/d_2(m\overline{R})$

mR chart

Upper Control Limit(R) $UCL_{mR} = D_4(m\overline{R})$

Center Line $CL_{mR} = (m\overline{R})$

Lower Control Limit(R) $LCL_{mR} = D_3(m\overline{R})$

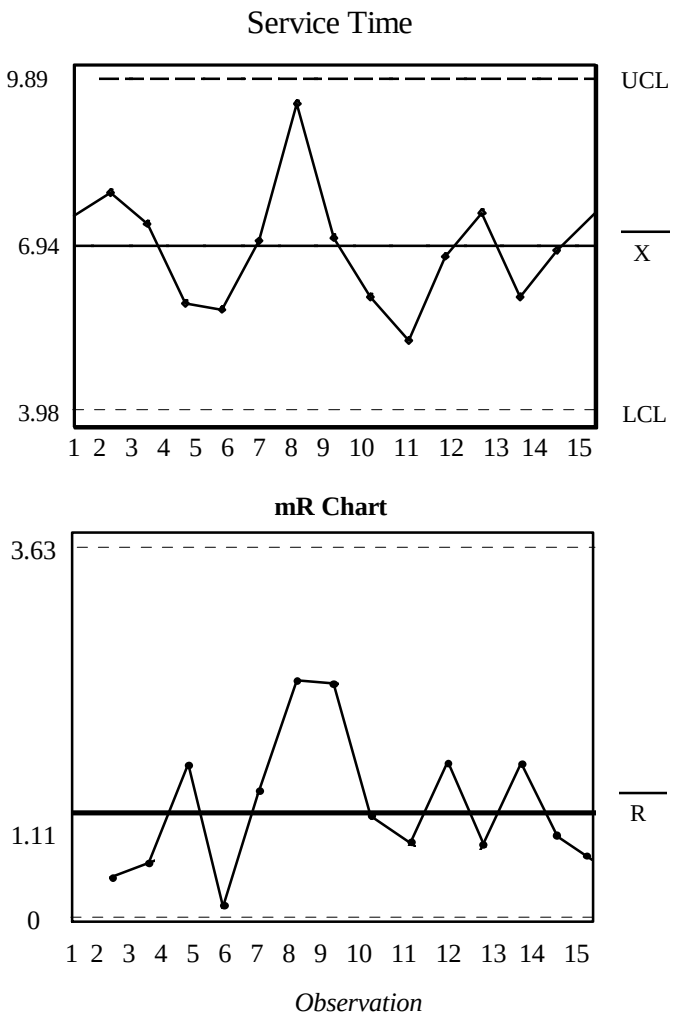
Plot the X values and draw the computed control limits—and your X chart is complete. Do the same for the mR chart.

An Example: This table shows individual customer service times (X) and moving range values for a process observed 15 times. Note that each mR is the absolute difference (no negative numbers) between the current X value and the previous X value (e.g., $|7.47-7.89| = 0.42$).

Customer Service Time Data

Number	Service Time (X)	Moving Range
1	7.47	
2	7.89	0.42
3	7.34	0.55
4	5.92	1.42
5	5.81	0.11
6	7.03	1.22
7	9.45	2.42
8	7.08	2.37
9	6.03	1.05
10	5.27	0.76
11	6.77	1.50
12	7.53	0.76
13	6.04	1.49
14	6.88	0.84
15	7.53	0.65
	$\overline{X}$ = 6.94	m$\overline{R}$ =1.11

The X and mR charts created from the data above are on the following page:



$\overline{X} - R$ charts

This chart uses subgroups of data collected over time to determine process variation.

Collect 20 to 30 subgroups of data. Each subgroup consists of two or more data points. For example, a subgroup could be a week, and its data points could be days. The size of each subgroup ("n") should remain constant. Total number of subgroups is represented by "k."

Determine the average ($\overline{X}$) and range (R) for each subgroup:

$$\overline{X} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{\sum x}{n}$$

$$R = x_{\max} - x_{\min, \text{ by subgroup}}$$

Determine the overall mean ($\overline{\overline{X}}$):

$$\overline{\overline{X}} = \frac{\sum \overline{X}}{k}$$

Take the sum of all the subgroup averages divided by the number of subgroups.

Determine the average value of the range ($\overline{R}$):

$$\overline{R} = \frac{\sum R}{k}$$

Take the sum of all the subgroup ranges divided by the number of subgroups.

Calculate the control limits and centerline using these formulas and constants:

$\overline{X}$ chart

Upper Control Limit($\overline{X}$) $UCL_{\overline{X}} = \overline{\overline{X}} + A_2 \overline{R}$

Center Line ($\overline{X}$) $CL_{\overline{X}} = \overline{\overline{X}}$

Lower Control Limit($\overline{X}$) $LCL_{\overline{X}} = \overline{\overline{X}} - A_2 \overline{R}$

R chart

Upper Control Limit(R) $UCL_R = D_4 \overline{R}$

Center Line $CL_R = \overline{R}$

Lower Control Limit(R) $LCL_R = D_3 \overline{R}$

Observations per subgroup		And for an R chart...	
		Use this value for	Use this value for
n	A_2	D_3	D_4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78

Plot the charts. Always use these charts in tandem. The $\overline{X}$ chart shows sample-to-sample changes in a process, and the R chart shows the variability within each sample. Recalculate the control limits if there is a significant change in the process average or variability—one of the "signals" mentioned earlier.

Customers complained the program office took too much time to process documents submitted for approval. That's why the program manager decided to analyze the office's approval process. He studied ten weeks' work and noted the turnaround times for five documents in each week. Take a look:

Approval time for documents

Week	Doc. 1	Doc. 2	Doc. 3	Doc. 4	Doc. 5	$\overline{X}$	R
1	36 days	33 days	43 days	51 days	33 days	39.2 days	18 days
2	31	50	33	54	35	40.6	23
3	43	41	46	26	37	38.6	20
4	41	40	36	56	29	40.4	27
5	34	26	33	42	28	32.6	16
6	59	33	47	51	65	51.0	32
7	31	41	52	38	40	40.4	21
8	40	40	38	65	51	46.8	27
9	25	47	50	61	56	47.8	36
10	37	48	46	61	49	48.2	24
						$\overline{\overline{X}}$ = 42.56	$\overline{R}$ = 24.4

Here are the variables and constants used to prepare the chart:

$\overline{\overline{X}} = (39.2 + ... + 48.2)/10 = 42.56$

$\overline{R} = (18 + ... + 24)/10 = 24.4$

$UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R} = 42.56 + (0.58)(24.4) = 56.63$

$CL_{\overline{X}} = \overline{\overline{X}} = 42.56$

$LCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R} = 42.45 - (0.58)(24.4) = 28.48$

$UCL_R = D_4\overline{R} = (2.11)(24.4) = 51.48$

$CL_R = \overline{R} = 24.4$

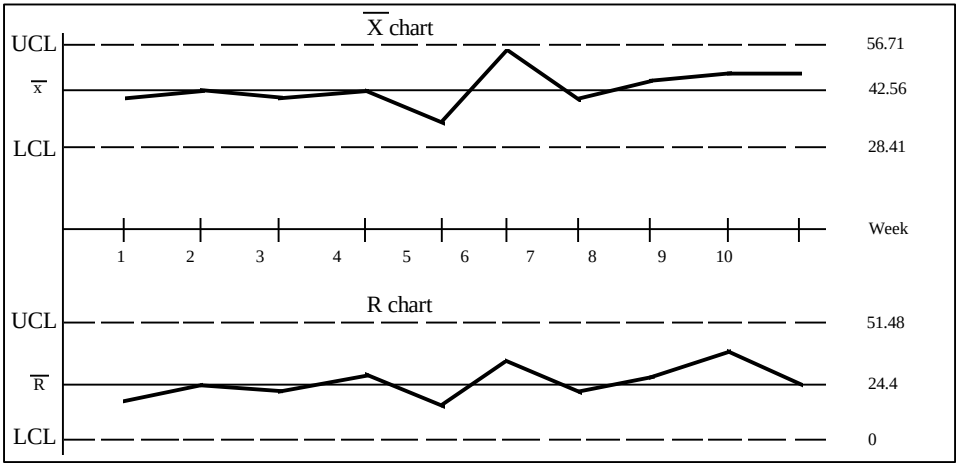
$LCL_R = D_3\overline{R} = (0)(24.4) = 0$

Where

k = 10 (number of weeks)

n = 5 (number of documents/week)

An Example: After reviewing the chart, the manager saw the approval process had been stable over time—the process was in control. That led the manager to wonder how the office's turnaround times related to customer expectations of a 30- to 60-day response. The manager decided to use a process capability analysis.



Attributes of control charts

There are two types of control charts to choose from— those for *defectives* and those for *defects*. Charts for defectives can show you the percentage of items that are defective, while charts for defects can show the number of defects on each item.

Use charts for defectives when an item's quality characteristic cannot be easily measured, but can be classified by the item either conforming (good or nondefective) or not conforming (bad or defective). Charts for defectives involve the fraction (percent) of defective items in a sample. Take a random sample of items and compare the number of defective items to the total number of items in the sample. For example, use this to establish the fraction of circuit boards rejected for bad solder joints.

Use charts for defects when determining the item's quality by the number of defects in the item, or by counting the number of occurrences of some event per unit of time. These charts involve the degree to which an item is defective (for example, the number of bad solder joints on a circuit board).

Decide which chart to use. This chart can help. (It is also acceptable to use XmR charts to analyze attribute data.)

When charting: sample size:	*Varied sample size:*	*Constant*
Defectives: A unit with one or more defects. Example: A memo with five words misspelled.	A **p-chart** will chart chart the fraction or percent defective.	A **np-chart** will chart the number of defectives in a subgroup.
Defects: An individual failure to meet a single requirement. Example: A misspelled word in a memo.	A **u-chart** will chart the number of defects per unit.	A **c-chart** will chart the number of defects in a subgroup.

*Collect 10-20 subgroups of data***.** Each subgroup (sample) consists of multiple data points arranged in a rational manner (day, lot, office, etc.). The size of each subgroup is represented by "n."

Compute the subgroup statistics and control limits for the type of chart that is being used. Use these formulas:

$$p = \frac{\text{number of defectives in subgroup}}{\text{size of subgroup(n)}} = \text{fraction or \% defective}$$

$$\bar{p} = \frac{\text{total defective}}{\text{total inspected}} = \text{centerline} = \text{average fraction defective}$$

$$\text{UCL} = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \text{upper control limit (varies by subgroup)}$$

$$\text{LCL} = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \text{lower control limit (varies by subgroup)}$$

plot p for each subgroup

Note: Use an average subgroup size to obtain a single set of control limits if the largest subgroup size is *less than twice the average* subgroup size and the smallest is *more than half the average* subgroup size.

Control Chart np-chart

$\bar{p}$, n = same as for p chart except n must be constant

$n\bar{p}$ = centerline = average number of defectives

$$\text{UCL} = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$$

$$\text{LCL} = n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$$

plot np for each subgroup

u-chart

$$u = \frac{\text{number of defects per subgroup}}{\text{number of units per subgroup}}$$

$$\bar{u} = \frac{\text{total number of defects for all subgroups}}{\text{total inspected}} = \text{centerline}$$

$$\text{UCL} = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}}$$

$$\text{LCL} = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$$

plot u for each subgroup

c-chart

$$c = \text{number of defects per group}$$

$$\bar{c} = \frac{\text{total defects}}{\text{total number of subgroups}} = \text{centerline}$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}}$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}}$$

$$\text{plot c for each subgroup}$$

An Example: A program director worried that changes to specifications might be excessive. To see if these concerns were well founded, the manager tracked the number of times per week a specification was changed by either an Engineering Change Proposal (ECP) or by a letter from the contracting officer. The table below shows the summary of changes for a ten-week period.

Note: The number of changes to specifications are attributes (counted)data, rather than variables data, and the c-chart is appropriate.

Week	1	2	3	4	5	6	7	8	9	10
Number of specifications changed	9	7	4	2	4	15	2	3	5	5

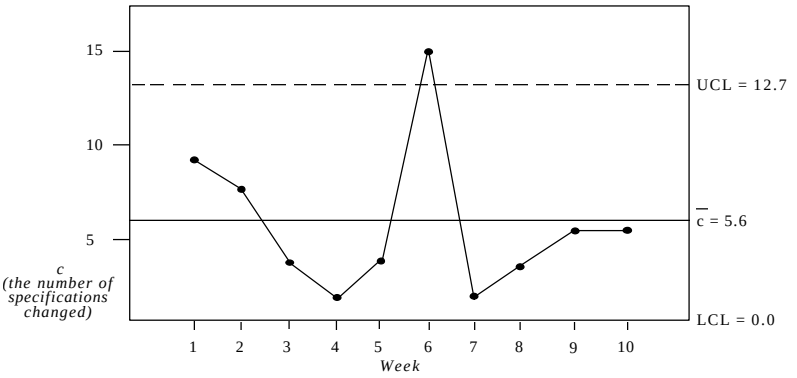
$$\bar{c} = \frac{56}{10} = 5.6 \text{ (changes per week)}$$

$$UCL = 5.6 + 3\sqrt{5.6} = 12.7$$

$$LCL = 5.6 - 3\sqrt{5.6} = -1.5 => 0$$

$$n = 50 \text{ active contracts}$$

The c-chart showed that week six contains a special cause for variation. The special cause was a design review held the previous week. Ten of the 15 changes in week six came from this design review. Pleased with the chart's results, the program manager adopted this control chart as a permanent management tool.



Process Capability Ratio

The Basics: Process capability ratios relate customer requirements to actual performance. While control charts measure the stability of a process over time, process capability ratios relate the variability of a process to the actual specification and tolerance requirements. These ratios are helpful when measuring how capable a process is of meeting customer requirements or relating process variability to specifications and tolerances. Finally, process capability ratios provide a link between control charts and customer requirements. Here's what to do:

The Process: *Obtain customer's requirements.* These requirements can be tolerances on drawings, delivery specifications, management objectives, etc.

Estimate the variability of the process being analyzed. Use the estimated standard deviation of the process to estimate the variability. That statistic is represented by $\hat{\sigma}$ (pronounced sigma hat). One way to estimate $\hat{\sigma}$ is to use the R chart from a process in statistical control. Here are equations and constants needed to obtain $\hat{\sigma}$:

$\overline{R}$ = overall average of subgroup ranges (centerline on R chart)

d_2 = a constant based on the subgroup size

n = subgroup size

Constants for estimating $\hat{\sigma}$

n	2	3	4	5	6	7	8	9	10
d_2	1.128	1.693	2.059	2.326	2.534	2.704	2.847	2.970	3.078

$$\hat{\sigma} = \frac{\overline{R}}{d_2} = \text{estimate of process standard deviation}$$

Compute the capability ratio of the process (C_p***).***

$$C_p = \frac{USL - LSL}{6\hat{s}}$$

where

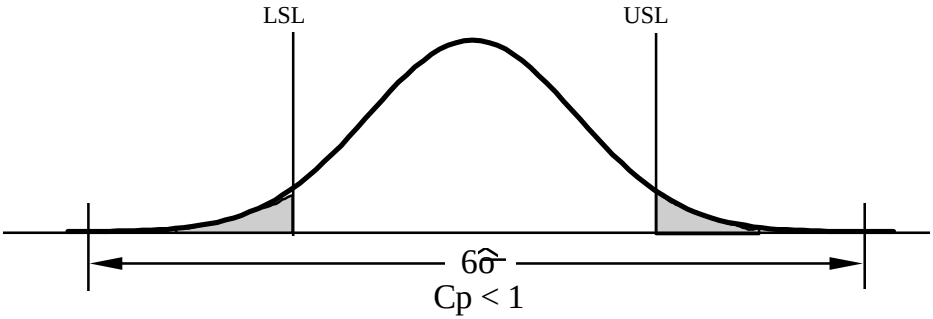
USL is the upper specification limit

LSL is the lower specification limit

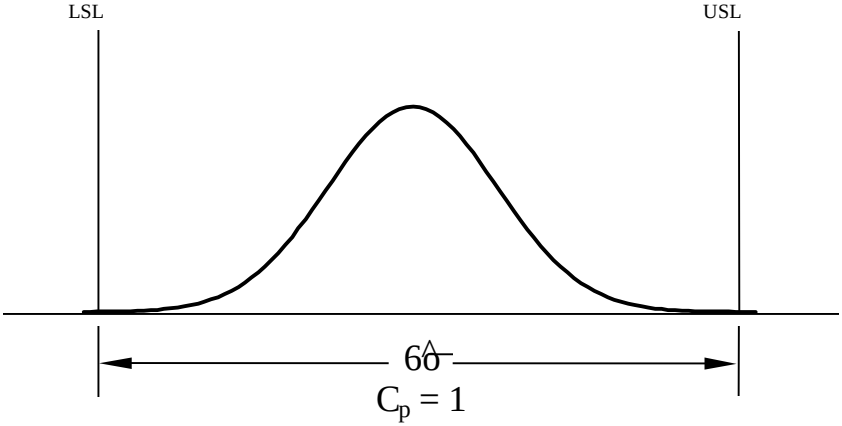
Cp is the capability ratio

A process with a C_p greater than or equal to 1.0 is considered capable. The customer's requirements can be met about 99 percent of the time using a capable process. If C_p is less than one, the requirements will be met less frequently. The figures on the next page illustrate the concept of C_p.

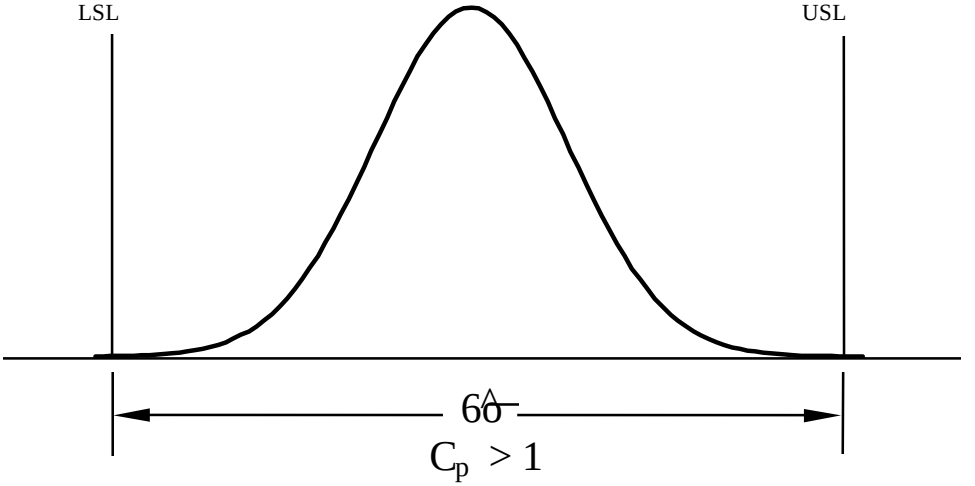
This is an *non-capable* process. The process variability is greater than the specification limits, so a large number of nonconformances will be made:



This is a *capable* process. The process variability is equal to the specification limits. If the process remains centered, specifications will be met about 99 percent of the time.



The process below is a desired process. The process variability is much less than the specification limits. Even if this process shifts off-center, the shift is detectable and can be corrected it without creating nonconformances.



Compute actual process performance. After determining the potential capability of the process, measure the actual performance of that process. The actual performance of a process is measured using the performance index. Compute this:

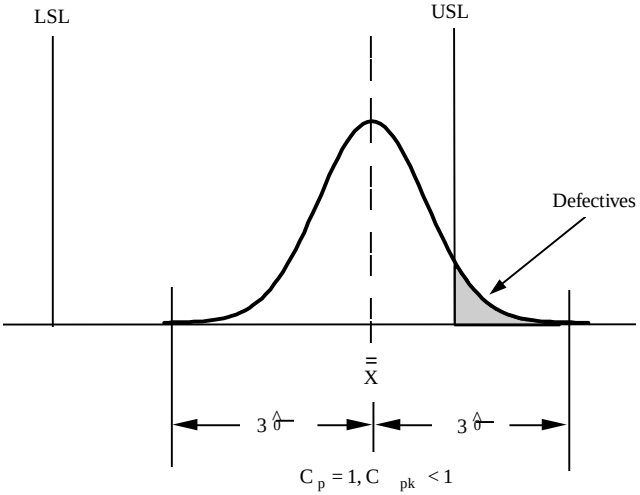
$$C_p = \frac{USL - \bar{\bar{x}}}{3\hat{s}}$$

$$C_{pl} = \frac{\bar{\bar{x}} - LSL}{3\hat{s}}$$

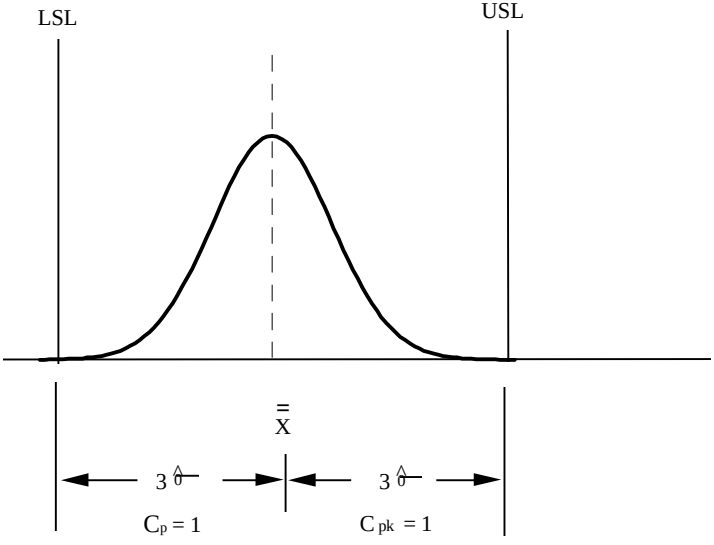
$$C_{pk} = \text{the minimum of } \{C_{pu}, C_{pl}\}$$

where $\bar{\bar{x}}$ is the overall average of subgroup averages (centerline on $\bar{x}$ chart)

A process with a C_{pk} less than C_p isn't centered between the specification limits. When computing C_{pk} for a capable process and it's less than 1, the process isn't centered. Here are two figures which illustrate the C_{pk} concept:



This capable process is **not** *centered within spec limits*



This capable process **is** *centered within spec limits:*

The manager used the data from that chart for this process capability ratio. He used the data to relate current process performance to the 30- to 60-day turnaround expected by contractors.

$$\bar{R} = 24.2;\ d_2 = 2.326;\ \text{and}\ \bar{\bar{x}} = 42.56$$

(data from the $\bar{x} - R$ chart)

$$\hat{\sigma} = \frac{\bar{R}}{d_2} = \frac{24.4}{2.326} = 10.49$$

With a USL of 60 days and an LSL of 30 days:

$$C_p = \frac{USL - LSL}{6\hat{\sigma}} = \frac{60 - 30}{6(10.49)} = 0.48$$

$$C_{pu} = \frac{USL - \bar{\bar{x}}}{3\hat{\sigma}} = \frac{60 - 42.56}{3(10.49)} = 0.55$$

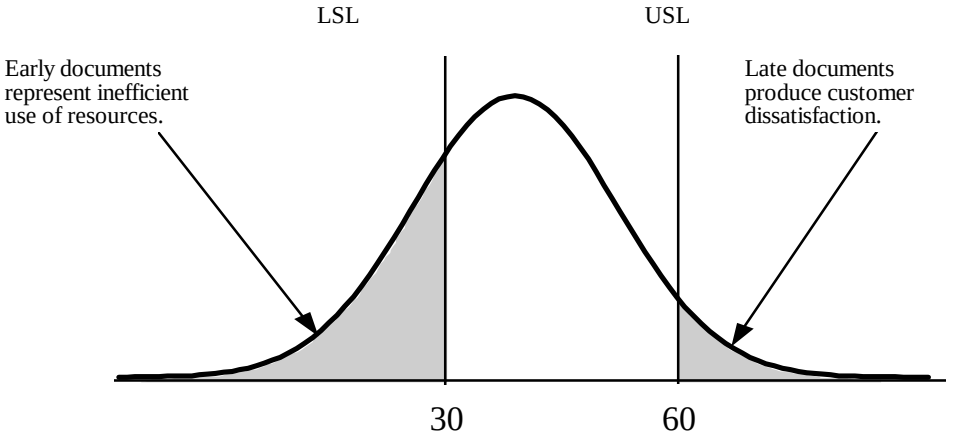
$$C_{pl} = \frac{\bar{\bar{x}} - LSL}{3\hat{\sigma}} = \frac{42.56 - 30}{3(10.49)} = 0.40$$

$$C_{pk} = \text{minimum}\ \{C_{pu}, C_{pl}\} = 0.40$$

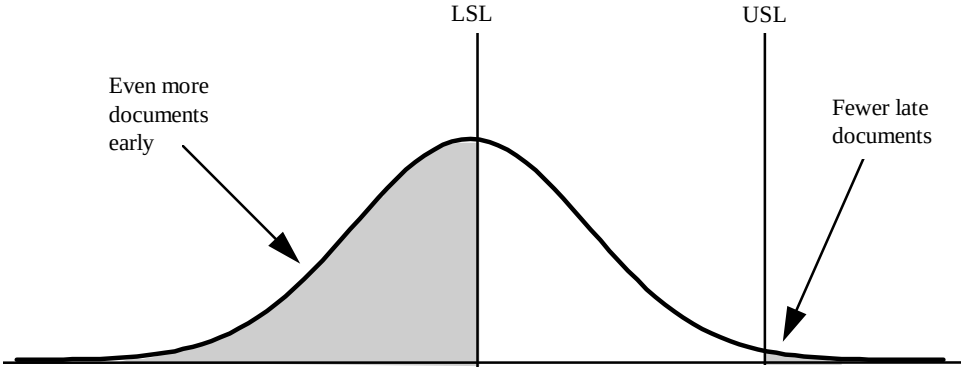
The C_p of 0.48 told the manager the requirement of a 30- to 60-day turnaround could only be met 83.6% of the time. (Although the process was in control, it wasn't capable.) Also, the C_{pk} of 0.4 showed the process wasn't centered.

The manager commissioned a team to investigate the process. He wanted the team to find ways to reduce variability so the 30- to 60-day requirement could be met more consistently. The manager briefed the team at the kickoff meeting and said, "Here's a picture of what our process looks like now.

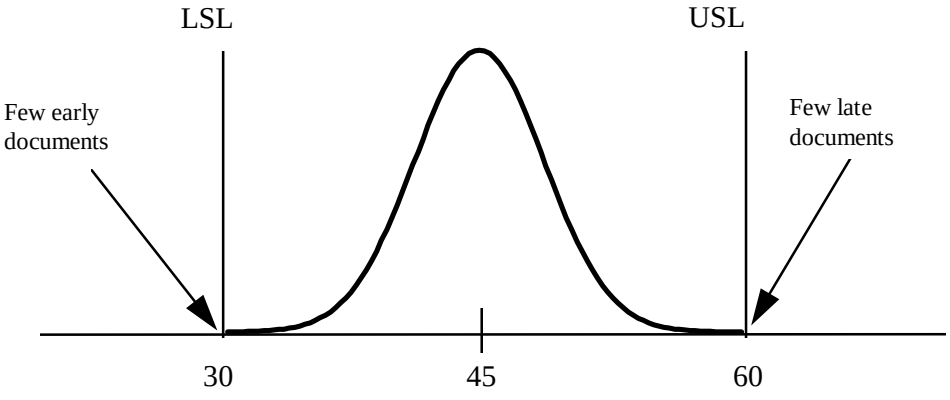
The late documents create customer dissatisfaction, and the early documents represent inefficient use of our resources." Here's the manager's graph:



The manager showed another graph and said, "The answer is not to speed up the entire process to get few documents taking longer than 60 days. This would shift the process to the left, leaving us with even more inefficient use of resources—and we'd still have too much variability." Here's the graph illustrating the manager's point:



Showing a third graph, the manager said, “The smart way to correct the situation is to reduce variability and center the process on 45 days, so we get a curve that looks like this.



B

QAF Glossary

Action plan -- Specific method or process to achieve the results called for by one or more objectives.

Action Workout -- An Action Workout is a rapid, concentrated, high-energy, team effort to make dramatic productivity improvements in any organization by reducing cycle time.

Affinity diagram -- A management tool that assists with general planning. It makes disparate language information understandable by placing it on cards and grouping the cards together in a creative manner. "Header" cards are used to summarize each group.

Air Force Mission --To defend the United States through control and exploitation of air and space.

Air Force Vision --Air Force people building the world's most respected air and space force...global power and reach for America.

Alignment --The process of improving a system so that all elements contribute to the aim.

Assessment -- A systematic process of collecting and analyzing data to determine the current, historical or projected status of an organization.

Assignable cause -- The name for the source of variation in a process that is not due to chance and therefore can be identified and eliminated.

Attributes, method of -- Measurement of quality by the method of attributes consists of noting the presence (or absence) of a characteristic or attribute in each unit in the group under consideration; counting how many units do (or do not) possess the quality attribute, or how many events occur in the unit, group or area.

Audit -- "The inspection and examination of a process or quality system to ensure compliance to requirements. Audit can apply to an entire organization or be specific to a function or production step." (Dr. Joseph M. Juran)

Autonomous department -- "A process unit which receives various inputs and converts them into finished goods and services, all within a single self-contained work center." (Dr. Joseph M. Juran)

Baldrige award -- "The Malcolm Baldrige National Quality Award (MBNQA) is an annual award to recognize American companies that excel in quality management and quality achievement." (MBNQA Criteria)

Baseline measurement -- A beginning point based on an evaluation of the output over a period of time to determine how the process performs prior to any improvement effort.

Best practice -- a superior method or innovative practice that contributes to improved performance.

Benchmarking -- The process of finding and adapting best practices to improve organizational performance.

Boxplot -- "A graphic summary of a distribution where the overall dispersion and the central tendency or mean of the data are highlighted." (Arturo Onnias)

Brainstorming -- An idea-generating technique that uses group interaction to generate many ideas in a short time period. Ideas are solicited in a non-judgmental, unrestricted manner from all members of a group.

Breakthrough -- "A change, a dynamic, decisive movement to new higher levels of performance." (Dr. J. M. Juran)

Cascading -- The continuing flow of the quality message down to—not through—the next level of supervision until it reaches all workers.

Catchball -- Continuous give-and-take between levels around chosen targets and organizational capabilities.

Cause -- An established reason for the existence of a defect or problem.

Cause-and-effect diagram -- A diagram graphically illustrating the relationship between a given outcome and all the factors that influence this outcome. Major categories often used are: manpower, machines, methods, materials; or people, procedures, policies, plant. (Also called a "fishbone diagram" or an "Ishikawa diagram.")

Centerline -- Represents the overall average operating level of the process.

Central tendency -- The tendency of data gathered from a process to cluster toward a middle value, somewhere between the high and low values of measurement.

Chart -- A tool for organization and summarization; aids in the analysis of data and displays organized information in graphic form.

Charter -- A written commitment by management stating the scope of authority for an improvement group. Resources, including time and money, are specifically addressed.

Checksheet -- A form for recording data on which the number of occurrences of an event can be recorded as ticks or checks.

Code of conduct -- Expectations of behavior mutually agreed upon by a team. (Also called "norms" or "rules of engagement.")

Common cause -- A source of process variation that is inherent to the process and is common to all the data.

Conformance -- The state of meeting and/or exceeding customer requirements and expectations.

Consensus -- A state where everyone in the group supports an action or decision, even if some of them don't fully agree with it.

Consensus decision -- A decision made after all aspects of an issue, both positive and negative, have been reviewed or discussed to the extent that everyone openly understands, supports and participates in the decision.

Consultant -- An individual who has experience and expertise in applying tools and techniques to resolve process problems and who can advise and facilitate an organization's improvement efforts.

Continuous improvement process -- "The idea that quality management and improvement is necessarily a continuous activity to ensure ongoing customer satisfaction and improved efficiency." (AT&T)

Control -- Keeping a process within boundaries; minimizing the variation of a process.

Control chart -- A problem solving statistical tool that indicates whether the system is in or out of control, as determined by computed control limits.

Control limits -- "Defines natural boundaries of a process within specified confidence levels" [upper control limit (UCL), and lower control limit (LCL) defined on a control chart]. (J. R. Russell)

Cost of quality -- The sum of the cost of prevention, inspection, and failure. The key financial measurement tool that ties process control and process optimization into a total process management effort. It can be used as an indicator and a signal for variation (more often, patterns of variation) as well as a measure of productivity and efficiency.

Cost of quality trend chart -- A chart reflecting the absolute and relative magnitudes of prevention, appraisal, failure and total quality costs over time.

Cost-benefit analysis -- A way to compare the costs and benefits of plans. Can be used for comparing the financial outcomes of different actions and determining if a particular action makes sense financially.

Countermeasure -- Action taken to counter the verified root cause of a problem.

Critical characteristic -- A characteristic dependent on the functioning of budget constraints, competitive edge and/or customer satisfaction of the product.

Critical dependencies -- The interrelationships existing within or among processes that are primary drivers of defects or errors in a product or service.

Critical issue -- Major unresolved requirements that keep a unit from reaching its desired future state. Selection of critical issues by senior leaders drives the goal-setting process.

Critical processes -- Processes that present serious dangers to human life, health and the environment, or risk the loss of very large sums of money and/or customers. Critical processes usually require numerous safety features to be built into the operational quality control system.

Cross-functional -- A term used to describe individuals from different organizational units or functions who are part of a team to solve problems, plan and develop solutions affecting the organization as a system.

Cultural resistance -- A form of resistance based on opposition to the possible social and/or organizational consequences associated with change.

Culture, organizational -- A common set of values, beliefs, attitudes, perceptions and accepted behaviors shared by individuals within an organization.

Culture change -- A major shift in attitudes, norms, sentiments, beliefs, values, operating principles and behavior of an organization.

Customer -- Anyone for whom an organization or individual provides goods or services. Can be internal or external.

Customer supplier alignment -- "Matching supplier capabilities (what's delivered) with customer needs (what's required). Applies to internal as well as external customers." (ODI)

Customer supplier model -- A model depicting inputs flowing into a work process that, in turn, adds value and produces outputs that are delivered to a customer. Throughout the process, requirements and feedback from the customer to the supplier monitor how well the process is meeting customer needs and expectations.

Customer supplier relationship -- The relationship between customers and suppliers attempting to align capabilities and requirements.

Data -- A set of facts presented in descriptive form. There are two basic kinds of data: measured (also known as variable), and counted (also known as attribute or enumerative data).

Defect -- State or condition of nonconformance to requirements.

Departmental task analysis -- A method for analyzing an organization by deter-mining its mission and how it interacts with customers and suppliers. Used to position the organization for improvement.

Design of experiments -- A branch of applied statistics dealing with planning, conducting, analyzing and interpreting controlled tests to evaluate the factors that control the value of a parameter or group of parameters.

Detection -- A reactive quality assurance strategy that attempts to identify unacceptable output after it has been produced and separated from the good output. (Also known as inspection.)

Deviation -- In data sets, the difference or distance of an individual observation or data value from the center point (often the mean) of the data set distribution.

Diagnosis -- The activity of discovering the cause(s) of quality deficiencies. The process of studying symptoms, taking and analyzing data, conducting experiments to test theories and establishing relationships between causes and effects.

Driving forces -- Forces that tend to change a situation in ways that you want it changed.

Effect -- An observable action, result or evidence of a problem.

Empowerment -- Act of placing accountability, authority and responsibility for processes and products at the lowest possible level. Whether or not a person is truly empowered depends on their acceptance of responsibility and accountability, their capabilities, and the seriousness of the consequences.

Enable -- Removing the barriers to empowerment.

Expectations -- Customer perceptions about how your products and services will meet specific customer needs and requirements. Expectations for a product or service are shaped by many factors including:

- The specific use the customer intends to make of it
- Prior experience with a similar product or service
- Representations and commitments (marketing and advertising descriptions)

External customers -- Those who use the product or the service supplied by the organization, but are not members of the organization that produces the product.

External failure -- Nonconformance identified by external customers.

Facilitator -- A person specially trained who functions as a teacher, coach, and moderator for a group, team or organization. In quality improvement, the facilitator focuses on group process while the team leader focuses on content.

Failure -- The inability of an item, product or service to perform required functions on demand due to one or more defects.

Feedback -- "Communication from the customer about how process output compares with customer expectations." (AT&T)

Fire fighting -- "The activity of getting rid of sporadic quality troubles and restoring the status quo." (Dr. Joseph M. Juran)

Fishbone diagram -- See *Cause-and-effect diagram*.

Five "whys" -- A technique for discovering the root cause(s) of a problem and showing the relationship of causes by repeatedly asking the question "Why?"

Flowchart -- A graphic, structured representation of all the major steps in a process.

Force field analysis -- A technique that helps you identify and visualize the relationships of significant forces that influence a problem or a goal.

Frequency distribution -- A statistical table that graphically presents a large volume of data in so that the central tendency (average/mean, etc.) and distribution are clearly displayed.

Function -- A group of related actions contributing to a larger action.

Gain sharing -- A reward system that shares productivity gains between owners and employees. Gain sharing is generally used to provide incentive for group efforts toward improvement.

Gatekeepers -- Individuals who help others enter into a discussion (gate openers) and those who cut off others or interrupt them (gate closers).

Gap analysis -- The comparison of a current condition to the desired state.

Goal -- "A broad statement describing a desired future condition or achievement without being specific about how much and when." (Government Performance and Results Act of 1993)

Government Performance and Results Act of 1993 -- The law provides for the establishment, testing and evaluation of strategic planning and performance measurement in the Federal Government. (Public Law 103-62, August 3, 1993)

Group dynamics -- An ongoing process involving interaction of individuals within a team to achieve the desired objective.

Hawthorne effect -- Every change results (initially, at least) in increased productivity.

Histogram -- A chart that takes measurement data (e.g., temperature) and displays its distribution. A histogram reveals the amount of variation within any process.

House of quality -- A product planning matrix developed during quality function deployment that shows the relationship of customer requirements to the means of achieving these requirements. The matrix indicates the impact each of the means has on one another.

Hoshin Planning -- Helps to control the direction of the company by orchestrating change within a company. This process includes both long- and short-range planning and focuses annual objectives on one or two key areas for breakthrough efforts. The key is that it brings the total organization into the strategic planning process, both top-down and bottom-up. It ensures that the direction, goals, and objectives of the company are rationally developed, well defined, monitored, clearly communicated, and adapted based on system feed-back.

Imagineering -- Developing in the mind's eye; a process without waste.

Implementation -- A structured approach that addresses all aspects (who, what, when, where, why, and how) of incorporating improvements into the process or system.

Improvement -- The organized creation of beneficial change; the attainment of unprecedented levels of performance. Levels of improvement range from incremental to major; e.g., "breakthrough" improvement.

In control -- Describes a process that has variations which fluctuates between the computed control limits. It may indicate the process is behaving as desired or that any problems can be attributed to the process. A process "in control" is stable and therefore predictable.

Indicators -- "Measures of how well you are meeting customers' needs and reasonable expectations. They are measures of the degree and/or frequency of conformance to valid requirements." (Qualtec Quality Services, Inc.)

Inhibitors -- Individual managers and/or workers unwilling to promote improvement activities regardless of demonstrated results or reasoning.

Inputs -- Products or services obtained from others (suppliers) in order to perform your job tasks.

Inspection -- Process of measuring, examining or testing a product service against some requirement to identify nonconformance before it reaches a customer.

Inspection costs -- Cost associated with inspecting the product to ensure that it meets the customer's (internal or external) needs and requirements.

Internal customers -- "Those who are impacted by the product or service and are also members of the organization that produces the product or service." (Dr. Joseph M. Juran)

Internal failures -- "Product failures that occur before the product is delivered to external customers." (Dr. Joseph M. Juran)

Intervention -- The role of team facilitator when he or she interrupts a group to state his or her observations about the group dynamics.

Ishikawa diagram -- See *Cause-and-effect diagram.*

ISO Standards -- The International Organization for Standardization compiled the ISO 9000-9004 quality standards. These are a set of individual but related international standards on quality management and quality assurance developed to help organizations effectively document the quality system elements to be implemented to maintain an efficient quality system. The standards are a starting point, not a finishing line.

Juran Trilogy -- "The three managerial processes used in managing for quality: quality planning, quality control and quality improvement." (Dr. Joseph M. Juran)

Just-in-time (JIT) -- A concept where an item is delivered, just-in-time, where and when it is needed.

Just-in-time inventory -- The minimum inventory required to meet production schedules.

Just-in-time training -- A process of providing training when it is needed. Eliminates the need for refresher training due to subject knowledge loss experienced if training precedes, over an extended period of time, the knowledge use.

Kaizen -- "Kaizen means improvement. Moreover it means continuing improvement in personal life, home life, social life, and working life. When applied to the workplace, Kaizen means continuing incremental improvement involving everyone—managers and workers alike." (Kaizen Institute)

Kanban -- "A communications tool in the 'just-in-time' production and control system. A kanban, or signboard, is attached to specific parts in a production line signifying the delivery of a given quantity. When all parts have been used, the same sign is returned to its origin where it becomes an order for more." (Kaizen Institute)

Key interface -- "The principal channel of interaction between customer and supplier." (Dr. Joseph M. Juran)

Key process -- The major system level processes that support the mission and satisfy major customer requirements. The identification of key processes allows the organization to focus its resources on what is important to the customer.

Key result area -- A major category of customer requirements that is critical for the organization's success.

Measurement -- The act or process of quantitatively comparing results to requirements to arrive at a quantitative estimate of performance.

Metric -- A measurement, taken over a period of time, that communicates vital information about a process or activity. A metric should drive appropriate leadership or management action. Physically, a metric package consists of an operational definition, measurement over time and presentation.

Mental imaging -- A technique that uses the imagination of experienced or informed persons to visualize success.

Mission -- The mission of an organization (and of an activity) describes its reason for existence. Mission statements are broad and expected to remain in effect for an extended period of time.

Multivoting -- A structured voting process used to reduce a large number of items, usually ideas, to a more manageable number for further processing or analysis.

Natural working group -- A group of people, similar to process action teams (PATs), except the process to be improved is owned and operated by the members of the group rather than senior leaders or process owners.

Nominal group technique (NGT) -- A tool for generating a list of ideas or opportunities (allows individuals to express their opinion). Priorities are determined by voting and ranking. The nominal group technique consists of the following steps:

- Individuals silently generate ideas without prior discussion; all idea s are written on a board, flip chart or pinned to the wall
- The group discusses ideas to identify, clarify and combine what has been written
- Votes are taken to establish the priorities, or ratings, of the various items using weighted, multivoting or a similar technique
- Optionally, these steps can be followed by a discussion of the results and a second vote

Non-value added -- Not essential to the achievement of process output.

Objective -- A specific statement of a desired shorter-term condition or achievement. Includes measurable end results to be accomplished by specific teams of people within time limits. It is the "how, when and who" for achieving a goal.

Outputs -- Products, materials, services, or information provided to customers (internal or external).

Out of control -- Describes a process that has variations which fluctuate outside the computed control limits. This condition normally indicates the process is not operating as desired or that external factors have been introduced. A process "out of control" is not stable and therefore is not predictable.

Pairwise ranking -- A group decision-making and prioritization method. Used to prioritize groups of items via comparison of predetermined criteria.

Paradigm -- A set of rules and regulations that defines boundaries and tells what to do to be successful within these boundaries.

Pareto chart -- A statistical method of measurement to identify the most important problems through different measurement scales; e.g., frequency, cost, etc. It directs attention and efforts to the most significant problems.

PDSA -- Plan-Do-Study-Act: a structured, cyclical methodology for developing and implementing actions of any type: Plan for the action by collecting and analyzing data and developing alternatives; Do, implement the selected alternative (preferably on a small scale); Study, evaluate results and compare expected values; Act, standardize action and/or start over. (Shewhart Cycle, Deming Wheel)

Performance standard -- No deviation from agreed-upon valid internal or external criteria.

Policy -- Overarching plan (direction) for achieving an organization's goals.

Policy deployment -- Process for developing and deploying an organization's plans and goals to the implementation level (top down) and then actions and metrics to achieve them (bottom up). It is very similar to Hoshin planning.

Policy management -- Targeting the achievement of breakthroughs by concentrating organization efforts and resources on a few priority issues. By doing this you: increase performance levels, improve communication of organization and unit direction and ensure broad participation in the development and attainment of long-term and short-term goals.

Prevention -- A quality assurance strategy that attempts to identify and correct unacceptable service or product characteristics during the design, development or production phases.

Process -- "A set of interrelated work activities that are characterized by a set of specific inputs and value-added tasks that produce a set of specific outputs." (AT&T)

Process action team (PAT) -- A chartered team made up of members with a vested interest in improving a process whose scope and duration are clearly defined by the process owner.

Process Capability ratios -- A group of measures that relate customer requirements to actual process performance.

Process control -- The application of Plan-Do-Study-Act (PDSA) philosophy to daily activities necessary to meet the needs and expectations of the customer.

Process Improvement -- A structured team environment that allows your people to work together to continuously improve processes.

Process owner -- "The person who coordinates the various functions and work activities at all levels of a process, has the authority or ability to make changes in the process as required, and manages the process end-to-end so as to ensure optimal overall performance." (AT&T)

QAF Systems Model --A way of ensuring customer satisfaction through involvement of all people in reliably delivering quality products and services. The QAF system has three components: focus, quality in daily operations and the improvement process. The system is founded on leadership and revolves around the Air Force core values.

Quality -- Consistently meeting or exceeding customer expectations.

Quality advisor -- Assists and advises the commander in the use of QAF principles, concepts, tools and techniques to improve organizational, team and individual performance.

Quality Air Force (QAF) -- The Air Force approach to total quality management: a leadership commitment and operating style that inspires trust, teamwork and continuous improvement everywhere in the Air Force.

Quality audit -- "A systematic, independent examination and review to determine whether quality activities and related results comply with planned arrangements and whether the arrangements are implemented effectively and are suitable to achieve the objectives." (ASQC Quality Progress, Feb 92)

Quality circles -- "Quality improvement and self-improvement study groups composed of workers and their supervisor who functions as a leader." (ASQC Quality Progress, Feb 92)

Quality function deployment -- A system that translates customer requirements (voice of the customer) into technical requirements for each stage of development and/or production.

Quality management -- "The management of a process to maximize customer satisfaction at the lowest overall cost to the organization." (AT&T)

Quality tool -- Instrument or technique that supports the activities of process quality management and improvement.

Random cause -- A cause of variation due to chance and not assignable to any factor.

Requirements -- "Performance standards associated with specific and measurable customer needs; the 'it' in do it right the first time." (AT&T)

Restraining force -- Forces that tend to keep a situation from changing in the way that you would like it to.

Root cause -- "Original reason for nonconformance within a process. When the root cause is removed or corrected, the nonconformance will be eliminated." (AT&T)

Sampling -- The process of taking a small part or quantity of something for analysis.

Scatter diagram -- "A graphical technique to analyze the relationship between two variables." (ASQC Quality Progress, Feb 92)

Special cause -- Causes of variation, in a process, that arise because of special circumstances. They are not inherent parts of a process.

Stakeholder -- Any individual, group, or organization that will have a significant impact on, or will be significantly impacted by, the quality of the product or service you provide.

Statistical process control -- "The application of statistical techniques for measuring and analyzing the variation in processes." (Dr. Joseph M. Juran)

Statistical quality control -- "The application of statistical techniques for measuring and improving the quality of processes. SQC includes SPC, diagnostic tools, sampling plans and other statistical techniques." (Dr. Joseph M. Juran)

Statistics -- "Descriptive: involves the tabulation, depicting, and describing collections of data. Inferential: a formalized body of techniques characteristically involving attempts to infer the properties of a large collection of data from inspection of a sample of the collection." (Glass & Stanley)

Storyboard -- Technique to graphically display the methodology used and progress made by a process action team; a board, specifically designated to display information

Strategic planning -- The process by which an organization envisions its future and develops special quality strategies and plans to achieve that future.

Strategies -- A broad, multifaceted approach chosen by an organization that is intended to move the organization from where it is to where it wants to be. Strategies address one or more critical issues.

Stretch goals -- A set of goals designed to position the organization to meet future requirements.

Suboptimize -- The act of committing energy and resources to maximize a portion of a process or system that undermines the effectiveness of the overall process or system.

Subprocess -- The process that makes up a larger process.

Suppliers -- The source of materials, service or information input to a process. Suppliers can be internal or external to an organization or group.

Symptom -- "An observable phenomena arising from and accompanying a defect. Sometimes, but not always, the same word is used both as a defect description and as a symptom description; e.g., open circuit. More usually, a defect will have multiple symptoms; e.g., 'insufficient torque' may include the symptoms of vibration, overheating, erratic function, etc." (Dr. Joseph M. Juran)

System -- A group of interdependent processes and people that together perform a common mission.

Tampering -- The process of adjusting a stable process to try to compensate for a result that is undesirable or for a result that is extra good, the output that follows will be worse than if the tamperer had left the process alone.

Task -- Specific, definable activities to perform an assigned piece of work, often finished in a certain time.

Thematic content analysis -- A procedure for finding patterns in raw data.

Total quality -- A strategic integrated system for achieving customer satisfaction that involves all managers and employees and uses quantitative methods to continuously improve an organization's processes. Often combined with other words to indicate this approach to various organizational functions or activities, as in: total quality management, total quality leadership, total quality control or total quality culture.

Value added -- The parts of the process that add worth to the external customer.

Values -- The fundamental beliefs that drive organizational behavior and decision making. Stated values may or may not match real values as exhibited by behavior.

Variation -- The difference among individual outputs of the same process; common or special.

Vision -- An overarching statement of the way an organization wants to be. An ideal state of being at a future point.

Weighted criteria ranking -- A way to prioritize a list of issues, ideas or attributes by assigning weighted criteria to judge them.

Weighted voting -- A way to prioritize a list of issues, ideas or attributes by assigning points to each item based on its relative importance.

Zero defects -- A long range value or concept. It implies the need for never-ending improvement.

C

Case Study

A Quality Fable About Improvement

Once upon a time at a fighter wing in the American southwest, the duty day was sunup to sundown. Nobody knew why, but it had been that way for as long as anyone could remember. The long hours were frustrating—for families, friends, flightline workers and aircrews. There had to be a better way. But while there were plenty of complaints, no one really knew what to do about the long duty days. Operations blamed maintenance, maintenance blamed the schedulers, and the families blamed everybody.

ü **CIP step 1** — Enter Capt F.W. Taylor. Capt Taylor had worked at the base quality office, and noticed several processes in his F15E squadron that needed improvement. He knew any process worth improving must meet two criteria. First, the process had to be consistent with Air Combat Command goals. Secondly, Capt Taylor needed a process that was significant to his unit's mission, but not overly ambitious.

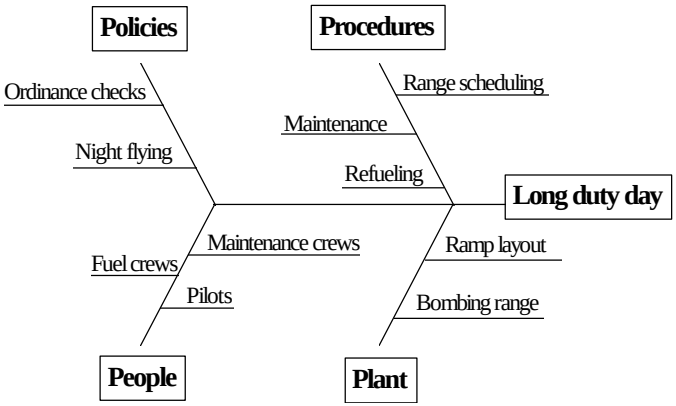
So Capt Taylor went to work. With help from Capt Deming, who worked in the quality office, and with inputs from the operations group commander, they decided to focus improvement efforts on the length of the crew's duty day. Some folks weren't sure the duty day needed attention. After all, the flyers knew maintenance could solve that problem by speeding up their turn times. On the contrary, said maintenance; they were convinced the schedulers needed to be more precise. Capt Taylor had to ask himself, "Would improving this process contribute towards the Air Combat Command mission or even the squadron's mission?"

ü **CIP step 1** — Nobody knew how changes would affect readiness and combat capability. Capt Taylor and Capt Deming surveyed internal and external customers and interviewed personnel. They explored how shortening the duty day would benefit all involved and ultimately benefit the mission.

ü **CIP steps 1 and 2** ¾ The survey cited strong reasons to reduce the length of the crew's duty day: shortening the day would increase the safety of both aircrews and maintenance while improving training. Other benefits included: improved relations between units, more debrief time between pilots and improved quality of life for all units involved with the F15E. The captains collected the customer requirements and identified the process owners. Then they created a team to examine and improve the process.

The team members were volunteers from all of the critical areas: operations, fuels, maintenance, weapons, safety programming and quality assurance. Team members, armed with impressive corporate knowledge, took their assignments seriously and attended a quality course. Capt Taylor was the team leader; Capt Deming was the facilitator.

ü **CIP step 2** — The group set out to collect data on all aspects of the process. The duty day was broken down into its critical components using the experience from the flying, maintenance and supply squadrons. Next, the components were assembled to give an 'as-is' picture of the process. The team used many tools to collect data, beginning with a flowchart of the existing process. That flowchart helped team members identify the questions they needed to ask, and focused everyone on the improvement process. After building the flowchart, the team created a fishbone diagram of the long duty day.

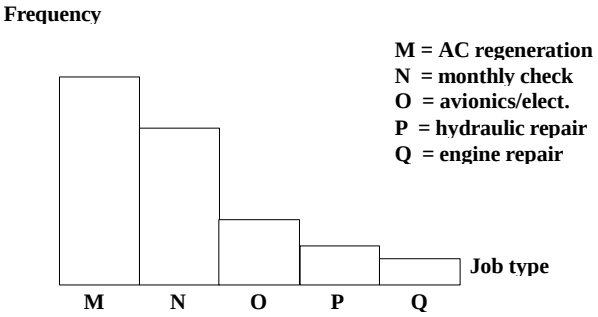


ü **CIP step 3** — The team slowly traced the cause-and-effect relationships in maintenance and scheduling. Those familiar with specific parts of the process took a new look when they explained it to others. The maintenance knowledge and weapons expertise of MSgt Goodwrench and MSgt Butterfinger proved especially helpful. The team discovered the length of the flying window (that's the time between the first launch and the last landing) drove the length of the duty day. The goal of the team was a reduction in the flying window—and consequently a reduction in the duty day. The flying window was designated the process metric—any reduction in its length would indicate a process improvement.

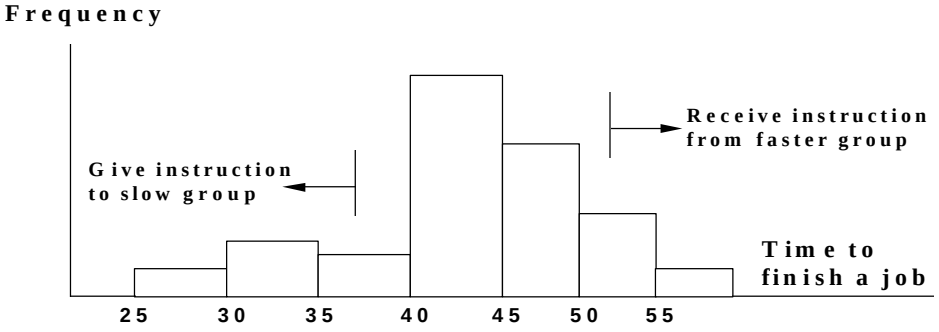
ü **CIP steps 2, 3, and 4** — The team used brainstorming and the five "whys" techniques to explore the cause-and-effect relationships between different actions and units. The team identified and removed some inefficiencies in the maintenance process, saving 30-45 minutes each day. An unnecessary ordinance check was eliminated—that saved another 30 minutes on some missions. Encouraged by their successes, the team kept working to shave even more time off the flying window.

ü **CIP step 3** — MSgt Goodwrench used a checksheet to develop a Pareto chart of maintenance jobs. The checksheet tallied how often a job was performed and the Pareto chart compared the frequencies of different jobs.

Then MSgt Goodwrench decided the most benefit could be derived from improving the most frequently performed action. She was right! That's why MSgt Goodwrench focused on the most common maintenance job: aircraft regeneration. She built a histogram of



different regeneration times. The histogram showed MSgt Goodwrench the average time it took to perform a job, and also showed how some performances varied.



ü **CIP steps 3 and 4** — When recording times for the histogram, MSgt Goodwrench always made sure crews performed equally well, and checked to be sure nobody "cut corners" while observed. To improve the routine, she asked those crews that turned in faster times to explain their procedures. The information was used to train the maintenance teams that were significantly slower than average.

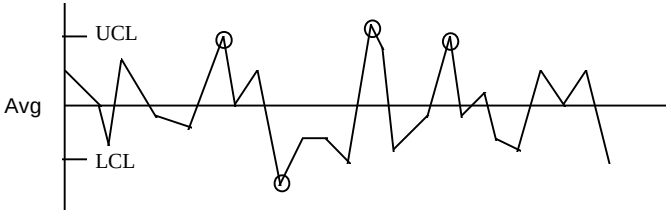
ü **CIP step 5** — This process eventually became the basis for in-house training programs to update and improve workplace skills. This reduced variation, improved skills and shaved more minutes off the flying window.

The teams also used checksheets, Pareto charts and histograms to evaluate the refueling process. Sgt Octane from the fuels flight used these tools to discover refueling often involved two trucks and averaged 45 minutes. In fact, 37 percent of the aircraft required a second fuel truck to finish refueling. Maintenance crews often had a long wait before the second truck arrived, and longer if they had to wait for the original truck to fill its tank and return. Those 45 minutes for refueling increased the time required between flights. Because of safety restrictions, no maintenance could be performed during aircraft refueling; that meant refueling had an enormous impact on the turn time and eventually on the flying window. To solve the problem, trucks were dispatched in pairs—that reduced the average F-15 refueling time to less than 30 minutes.

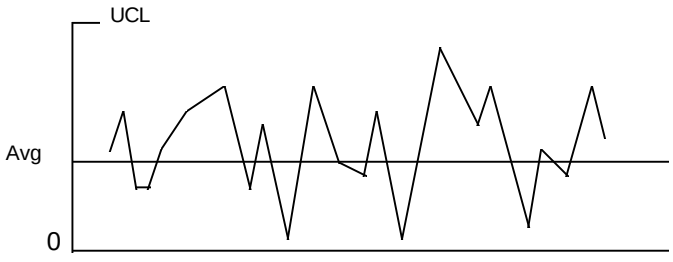
ü **CIP steps 5 and 6** — Most team members were surprised such a simple action could have such large payoff. Sgt Octane and his shop never knew waiting for the second truck to show up affected turn time. The people in fuels considered the time until a truck arrived as the gauge for customer satisfaction. Their measurements didn't include the time required to finish refueling, and so they didn't realize they weren't meeting their customer's

expectations. This lesson taught the group the value of selecting the proper metrics; team members vowed to emphasize them to all involved.

ü **CIP steps 2, 3, 5, and 6** — The team continually came up with new ideas and suggestions for improvement. The members had so many ideas, in fact, they needed to use multivoting and nominal group technique to prioritize their ideas. One accepted idea was to benchmark the repair process against team processes used at Exercise GUNSMOKE and Exercise RED FLAG. Further suggestions included charting the times for repair on a control chart. To make a chart, the team recorded the time local maintenance technicians needed to complete a repair. After enough jobs were observed to calculate limits, they plotted the average, lower and upper time limits of each specific job on X and MR charts. MSgt Goodwrench reviewed the 'time-to-fix' of the specific jobs. Then she studied the out-of-control points. She observed the out-of-control times happened to nearly all of her crew at one time or another; all ranks and experience levels had recorded slow times.



Control chart of repair times



Moving range of repair times

ü **CIP step 6** — MSgt Goodwrench was confused. From the most experienced to the newest worker, everyone had recorded long repair times. Rank and training seemed to have no effect. What was wrong? When she investigated those incidents that exceeded the upper control limit, MSgt Goodwrench learned tools were late or unavailable—and so the longer repair times were recorded. When times recorded were shorter than expected, she learned crews had the tools available from the start of the job. Availability of tool packages directly affected the length of time needed to complete a repair. And although crew chiefs frequently complained about the lack of tool packages, maintenance had exceeded its tool quota. There had to be a better way. Maintenance came up with the idea of having the ramp supervisor 'spot' unused or soon-to-be-finished tool packages and radio their location to the hanger. Tools became available as soon as the current job was finished instead of waiting until the job was finished and the kits returned. That reduced turnaround times, and the flying window shrunk even more.

ü **CIP steps 3, 5, and 6** — All these initiatives yielded 20 recommendations—and most were implemented. Deliberate team effort and open discussion made this happen. There were no quick solutions; the incremental and continuous improvement took many

months. Eventually the flying window was cut by hours. That led to a corresponding drop of four hours in the duty day. Before the team worked on the process, the flying window exceeded eight hours 40 percent of the time. After the improvements, the flying window rarely exceeded eight hours. The maintenance crews were happy with the shorter hours and increased efficiency, the aircrews were happy with the shorter hours and increased training and that made the families happier, too. Air Combat Command enjoyed increased combat capability, the units enjoyed better relations and everyone enjoyed an increased quality of life. This story has a happy ending.

D

Benchmarking Code of Conduct

Preamble ¾ To guide benchmarking encounters and enhance the professionalism and effectiveness of benchmarking, the International Benchmarking Clearinghouse, a service of the American Productivity & Quality Center, and the Strategic Planning Institute Council on Benchmarking have adopted this common Code of Conduct. We encourage all organizations to abide by this Code of Conduct. Adherence to these principles will contribute to efficient, effective, and ethical benchmarking.

Individuals agree for themselves and their organization to abide by the following principles for benchmarking with other organizations.

1. Principle of Legality.

- If there is any potential question on the legality of an issue, don't do it
- Avoid discussions or actions that could lead to or imply an interest in restraint of trade, market, and/or customer allocation schemes, price fixing, dealing arrangements, bid rigging, or bribery. Don't discuss costs with competitors if costs are an element of pricing

- Refrain from the acquisition of trade secrets from any means that could be interpreted as improper, including the breach or inducement of a breach of any duty to maintain secrecy. Do not disclose or use any trade secret that may have been obtained through improper means or that was disclosed by another in violation of a duty to maintain its secrecy or limit its use. Do not, as a consultant or client, extend one benchmarking effort's findings to another organization without first obtaining permission from the parties of the first effort

2. Principle of Exchange

- Be willing to provide the same type and level of information that you request from your benchmarking partner to your benchmarking partner
- Communicate fully and early in the relationship to clarify expectations, avoid misunderstandings, and establish mutual interest in the benchmarking exchange. Be honest and complete

3. Principle of Confidentiality

- Treat benchmarking interchanges as confidential to the individuals and organizations involved. Information must not be communicated outside the partnering organizations without the prior consent of the benchmarking partner who shared the information
- An organization 's participation in a study is confidential and should not be communicated externally without its prior permission

4. Principle of Use

- Use information obtained through benchmarking only for purposes of formulating improvement of operations or processes within the organizations participating in the benchmarking effort
- The use or communication of a benchmarking partner's name with the data obtained or practices observed requires the prior permission of that partner
- Do not use benchmarking as a means to market or sell

5. Principle of First Party Contact

- Initiate benchmarking contacts, whenever possible, through a benchmarking contact designated by the partner organization
- Respect the corporate culture of partner organizations and work within mutually agreed upon procedures
- Obtain mutual agreement with the designated benchmarking contact on any hand-off of communication or responsibility to other parties

6. Principle of Third Party Contact

- Obtain an individual's permission before providing his or her name in response to a contact request
- Avoid communicating a contact's name in an open forum without the contact's permission

7. Principle of Preparation

- Demonstrate commitment to the efficiency and effectiveness of benchmarking by completing preparatory work prior to making an initial benchmarking contact and following a benchmarking process
- Make the most of your benchmarking partners' time by being fully prepared for each exchange

- Help your benchmarking partners prepare by providing them with an interview guide or questionnaire and agenda prior to benchmarking visits

8. Principle of Completion

- Follow through with each commitment made to your benchmarking partners in a timely manner
- Complete each benchmarking effort to the satisfaction of all benchmarking partners as mutually agreed

9. Principle of Understanding and Action

- Understand how your benchmarking partners would like to be treated
- Treat your benchmarking partners in the way that you would like to be treated
- Understand how each benchmarking partner would like to have the information he or she provides handled and used, and handle and use it in that manner

E

Suggested Reading

1. ***Benchmarking: The Search for Best Practices that Lead to Superior Performance*** by Robert Camp (ASQC Press, 1989)

2. ***The Deming Management Method*** by Mary Walton (The Putnam Publishing Group, 1986)

3. ***Employee Driven Quality: Releasing the Creative Spirit of Your Organization Through Suggestion Systems*** by Robin E. McDermott, Raymond J. Mikulak, and Michael R. Beauregard (Quality Resources, 1993)

4. ***The Empowered Manager: Positive Political Skills at Work*** by Peter Block (Jossey-Bass Inc., 1987)

5. ***Excellence in Government*** by David K. Carr and Ian D. Littman (Coopers and Lybrand, 1991)

6. ***The Fifth Discipline*** by Peter M. Senge (Doubleday Publishing, 1990)

7. ***Five Pillars of TQM*** by Bill Creech (The Penguin Group, 1994)

8. ***From Red Tape to Results: Creating a Government That Works Better and Costs Less: Report of the National Performance Review*** by Vice President Al Gore (US Government Printing Office, Superintendent of Documents, 1993)

9. ***The Goal*** by Eliyahu M. Goldratt and Jeff Cox, Second Revised Edition (North River Press Inc., 1992)

10. ***Guide to Quality Control*** by Kaoru Ishikawa (Quality Resources, 1993)

11. ***Hoshin Kanri: Policy Deployment for Successful TQM*** by Yoji Akao (Productivity Press, 1991)

12. ***Juran on Leadership for Quality: An Executive Handbook*** by Joseph M. Juran (Juran Institute, Inc., 1989)

13. ***Kaizen: The Key to Japan's Competitive Success*** by Masaaki Imai (McGraw-Hill 1986)

14. ***The Language of Total Quality*** by Arturo Onnias (TPOK Publications of Quality, 1992)

15. ***Making Meetings Work: A Guide for Leaders and Group Members*** by Leland P. Bradford, Ph.D., L. H. D. (Pfeiffer and Company, 1976)

16. ***Managing the Total Quality Transformation*** by Thomas H. Berry (McGraw-Hill, 1991)

17. ***Memory Jogger Plus*** by Michael Brassard (Goal QPC, 1989)

18. ***The Metrics Handbook*** (AFMC Pamphlet 90-102, May 1995)

19. ***The New Economics: For Industry, Government Education*** by W. Edwards Deming, Third Printing (Institute of Technology 1993)

20. ***Plan or Die*** by Timothy Nolan and Leonard Goodstein, William Pfeiffer (Pheiffer and Company, 1993)

21. ***Process Improvement Guide: Quality Tools for Today's Air Force*** by the Air Force Quality Institute, Second Edition (AFQI, 1994)

22. ***Profiles for Performance: Total Quality Methods for Reducing Cycle Time*** by Jack H. Fooks (Addison-Wesley Publishing Company, 1993)

23. ***Simplified Baldrige Award Organization Assessment*** by Donald C. Fisher, Ph.D. (The Lincoln-Bradley Publishing Group, 1993)

24. ***SPC Simplified for Service - Practical Tools for Continuous Improvement*** by D.M. Amsden, R.T. Butler and H.E. Butler (Quality Resource, 1991)

25. ***Statistical Quality Control Handbook*** by AT&T, (AT&T Technologies, 1956)

26. ***Strategic Benchmarking*** by Gregory H. Watson, (John Wiley & Sons, Inc., 1993)

27. ***Team Building: An Exercise in Leadership, Revised Edition*** by Robert B. Maddux (Crisp Publications, 1992)

28. ***The Team Handbook*** by Peter R. Scholtes, (Joiner Associates, 1994)

29. ***Total Quality Transformation Improvement Tools*** by PQ Systems Inc. (PQ Systems Inc., 1994)

30. ***Walk the Talk...and get the results you want*** by Eric Harvey and Alexander Lucia (Performance Publishing, 1995)

Index

Quality Approach (QA) Reader Feedback Form

Please help us make future editions of the Quality Approach more useful to you by answering the following questions and sending us your responses. Use the scale below to evaluate the questions

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Very Dissatisfied	Dissatsified	Somewhat Satisfied	Satisfied	Very Satisfied
1	2	3	4	5

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1. I am ___with the breadth of topics 1 2 3 4 5
2. I am ___with the depth of topics 1 2 3 4 5
3. I am ___with the clarity of writing 1 2 3 4 5
4. I am ___with the examples used 1 2 3 4 5
5. I am ___that I can apply the QA readings to my work 1 2 3 4 5
6. Overall I am ___ that I read the QA 1 2 3 4 5

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7. What topics can we eliminate from the QA?

8. What topics do we need to add/expand in the QA?

9 My rank/grade is_____My AFSC/skill code is _____

Please tear out this page and mail/FAX your responses to

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